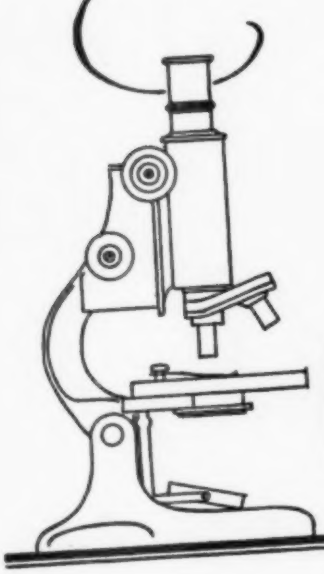


The Science Counselor

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

VOLUME I
NUMBER 4
DEC., 1935

DUQUESNE
UNIVERSITY
PRESS

The Science Counselor

A QUARTERLY JOURNAL *of teaching methods and scientific information for teachers of science in the Catholic high schools. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

THE DUQUESNE UNIVERSITY PRESS

Subscription Price: $1.00 per year; Canada, $1.25. Single copies of issues in the current year, 35c each.
Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh, Pa.

Volume I. DECEMBER, 1935 No. 4

CONTENTS

With the Editor . . .

With the present issue THE SCIENCE COUNSELOR completes its first year,—a year that has been interesting, extremely busy, and, to the editors at least, highly instructive. We take advantage of this opportunity to express publicly to our editorial, business, and printing staffs our sincere appreciation of their cooperation and courteous helpfulness during the year.

To those who have contributed articles, we are deeply obliged. Most of our authors are educators, carrying full teaching schedules. All are busy men and women. We realize that the extra work of preparing papers involves an expenditure of time and effort that is not always easy to make. We are sure, however, that our writers will agree that the sacrifices they have made have been in a good cause.

We appreciate the valuable patronage of our subscribers and of our advertisers. With an especial gratitude that surely is felt by many of our Catholic teachers, also, we acknowledge the very considerable financial assistance and the wise counsel of the President and other administrative officers of Duquesne University, without whose aid this journal could not have become a reality.

We are grateful to the many readers and subscribers who have expressed their approval of the aims and policies of THE SCIENCE COUNSELOR and of the manner in which these are being accomplished. We value highly the friendly interest of those who have made suggestions for the improvement of our magazine.

Our correspondence leads us to feel, modestly, that our first numbers have been interesting, inspiring, and helpful to teachers of high school science everywhere. It is our hope that our second volume will be better than the first. We must grow and develop and expand. To do so we need your help, both financial and literary. We ask for and hope to receive the continued support and assistance of those friends who have already cooperated with us. We solicit the help of other readers and teachers who can be of aid.

All must work together if we are to accomplish in any worth while way the purpose of this journal—to improve the teacher and the teaching of science in the Catholic high schools of America.

TILTING-CASE METERS

Accuracy — 2 Per Cent

The new and exclusive tilting-case feature of this meter permits instant and direct alignment of the scale with the eyes whether used for laboratory or lecture work, thus making readings easier, more comfortable and more accurate.

The case is held securely in any angular position, from horizontal to vertical, by a concealed adjustable screw located in the edge of the base.

Though low in cost this new Triplett Meter offers exceptionally good electrical characteristics—about 125 ohms per volt, or 1250 ohms for a 10-volt range. Having a low current draw of only 8 M.A. for a full scale deflection, it makes an excellent measure for the small currents employed in experimental laboratory work. Has D'Arsonval Pattern D.C. Movements. Repulsion-Iron-Vane type A.C. Movements. Casing is metal (black for D.C., red for A.C.) hinged on moulded bakelite base. Scale is $2\frac{1}{4}$ inches long, lithographed in black on white-enameled metal and protected by full-circle glass cover which provides maximum illumination under all conditions. Supplied for D.C. or A.C. current

MILVAY TRIPLETT LABORATORY METERS

and for single or double range measurements of Milliammeters, Ammeters, Millivolt-meters and Volt-meters. Single-range instruments, $11.

SQUARE-CASE METERS

Accuracy — 1 Per Cent

Milvay Triplett Square-case Meters because of their special design and Superior Characteristics are ideally suited for both student and general laboratory use. Their accuracy, sensitivity, size and ruggedness are advantages found only in higher priced instruments. Nor will some of their valuable features be found in any other meters of like prices.

As examples of this remarkable meter's superiority it has an unusually high voltmeter resistance (125 ohms per volt, or 1875 ohms for a 15-volt range) with correspondingly low ohmic values of the shunts in the ammeter . . . current draw is but 8 M.A. for full scale deflection . . . construction of every part is of the finest workmanship and materials available . . . assembled with the extreme care and improved methods that assure ruggedness and maximum service under severest of laboratory conditions . . . has the fine mechanical construction, electrical characteristics and permanent magnetic qualities that assures and retains its high accuracy of 1 per cent . . . usable in either horizontal or vertical position . . . has new $4\frac{1}{4}$ inch, all-metal, easy-to-read lithographed scale . . . case is of bakelite, $5\frac{3}{8}$x$5\frac{3}{8}$x$2\frac{1}{4}$ inches . . . D'Arsonval Movements of watch-like precision in D.C. instruments, Repulsion-Iron-Vane type in A.C. Suitable for practically all amperage and voltage measurements required in experimental work, lecture demonstrations or general laboratory work. . . . Single-range instruments, $17.50.

MILVAY SCIENCE SUPPLIES

CHICAGO APPARATUS COMPANY

1735-43 NORTH ASHLAND AVENUE • CHICAGO

Translating Science Into News

● By Frank Thone, Ph.D., *(University of Chicago)*
LECTURER AND WRITER, SCIENCE SERVICE, WASHINGTON, D. C.

"The gospel of science should properly be preached by those who are writing it, who know its truths most intimately, and feel their significance most strongly . . . The people are ready to have the gospel preached to them . . . But most scientists remain ingloriously mute."

Dr. Thone is a scientist who both practices and preaches. He knows how to write. In this article he gives practical hints about preparing stories of scientific interest for the press. Perhaps there is a story in your laboratory or classroom.

●

Human social groups function best when they move unitedly like armies on the march. If the leaders, the advance guard, fail or neglect to maintain touch with the slower-moving main body, it is bad for all concerned. The leaders, perhaps glancing back from a height far out in front, may be dismayed to see that their army has fallen into disarray through lack of the information they should have been constantly sending back; or worse, interloping false leaders may have seized the opportunity to trick them down the wrong road toward ruin.

Time after time, in the long tragedy of human history, this has happened. The best minds of the people, eagerly pursuing some great good which they see clearly enough, have isolated themselves. Sometimes they have forgotten how to pass back to the main body the gist of the knowledge they have gained; sometimes they have fallen into the sin against their brothers, of thinking them incapable of understanding the message if they did send it.

And time after time the result has been the same. Without vision, the people perished, either floundering helplessly for want of counsel, or duped by heretics in religion, demagogues in statecraft, knaves in economics, charlatans in science.

When reformers have risen to set things right again, their first care has been to reëstablish contact with the people. It is not without significance that the great restorers of religion (Francis, Dominic, Bernard, Albert—to name only a random few) were not only themselves notable preachers, but were also most active in inspiring good preaching by the whole clergy, whether in their own orders or in ordinary, dusty, parochial jobs.

In so doing, they were following the most august of examples. Christ, concluding the swift catalogue of his works to convince the inquiring disciples of John the Baptist, came to a climax with "and the poor have the gospel preached to them." It was well enough to heal the blind, the deaf, the halt; but most important to put men into possession of those truths that could enable them to achieve for themselves spiritual sight, hearing, wholeness.

As with matters of the spirit, so also with things more mundane, of our own day. Modern natural science has made it possible to accomplish remedies of evil and promotions of good by entirely natural means, that were once beyond the reach of aught except the miraculous. At least some of the blind see, and some of the lame walk again; in our own day lepers are being cleansed; but despite the thousands of ardent disciples that science can boast, the poor, the uninstructed, hear the gospel of science from only a few tongues—and even among these, some have rather dubious claim to a license to preach.

This unfortunate state of affairs has perhaps at least a partial explanation in the history of natural science itself. Science has claimed its present large share in our common life so very recently that it has as yet hardly had time to get its activities well organized. Not that science is a new thing; its origins go back to a very respectable antiquity, as any textbook's opening chapter will tell you. But it had such an unconscionably long infancy. While other departments of human endeavor—religion, statecraft, the fine arts, even war—went through their development at a more or less even rate through many centuries, science lagged behind in an almost embryonic state—and then in two or three brief human generations spurted ahead to catch up with its brethren, and has even begun to boss the rest of the family around!

It is understandable, therefore, that the work of informing the people about at least the basic facts and significances of science has not yet been well performed. But it is no longer excusable—the less so, since further neglect becomes increasingly dangerous, with self-interested misinterpreters of the stripe of Nietzsche, Haeckel, Marx and Goebbels daily preaching distortions of science in support of their own distortions of philosophy.

The gospel of science should properly be preached by those who are writing it, who know its truths most intimately and feel their significance most strongly, because they themselves have wrought in their discovery. To some extent this has long been done. Charles Darwin's books, heavy though their style seems to us now, were "popular" in their day, for mid-Victorian literary digestions were tougher than ours. Louis Pasteur could not only lecture convincingly before a lay audience but he could also stage a scientific demonstration that could impress even a crowd of mixed farmers,

Continued on Page Twenty-nine

Laboratory Work for the Blind

● By Robert T. Hance, M.A., Ph.D., *(University of Pennsylvania)*
PROFESSOR OF BIOLOGY, UNIVERSITY OF PITTSBURGH

●

The need for eyes in laboratory study has seemed so obvious that we have frequently either waived or modified the graduation requirement of a laboratory science for those students without the normal powers of vision. An increasing number of blind students, well endowed mentally, are beginning to feel the need for training of the sort afforded by the college. Laboratory work has usually been assumed to be one phase of a college course that a blind student could not master. Chemistry as it is usually given is certainly not practical. On the other hand, being without sight has as a rule focused the attention of the blind on their own biological functions, and it has seemed a pity not to give them the advantages of our modern knowledge and to give this as it can only be done in the laboratory—through personal contact.

Laboratory work in biology for blind students? Impossible? To the average teacher the problem would be baffling. Not so to Dr. Hance.

Read what clever pioneering work is being done by an outstanding teacher in the biological field.

To carry a blind student through a course in biology is not an entirely new venture, as it has been done in other colleges with the aid of stock models of animals and plants and with plastocene modeling clay shaped to simulate structures not available in the models. Few laboratories have a very complete collection of models and, at the best, plastocene is a messy and temporary medium. In casting about for a material free of these difficulties and that would permit the rapid outlining of anatomical parts, the possibilities of soft wire presented themselves. Wire solder is about one eighth of an inch thick and very flexible. Soft aluminum wire comes in various thicknesses and can be used to differentiate smaller structures. In the beginning of our use of this wire we made a number of circles and rods of various sizes. Our "drawings" were then built up "tinkertoy" fashion with the proper combinations of circles and rods. It is interesting to discover how many variations of structure can be produced with a comparatively few changes in the arrangements of these rings and rods. These were not too satisfactory as the student could readily disarrange the parts as he felt them.

We then developed much more exact drawings in wire and cemented them to stiff card board with liquid solder. The parts are labelled in Braille which does away with much of the close supervision that the instructor thought was originally called for. The Braille labels are connected to the respective parts by a wire equivalent of the dotted line. Fine soft aluminum wire is wound tightly cork screw fashion about a thin mandrill like a heavy needle. This spiral is then pulled out to considerable length making it appear like a wavy line and feel like a series of dots as the finger passes over it. There are no other wires of this character on the chart; so the student knows when his fingers contact these spirals that they lead from organ or part to label. The accuracy as well as the artistic success of our collection of wire drawings is due to the skill of Miss Velva Seyler, a senior student in the department.

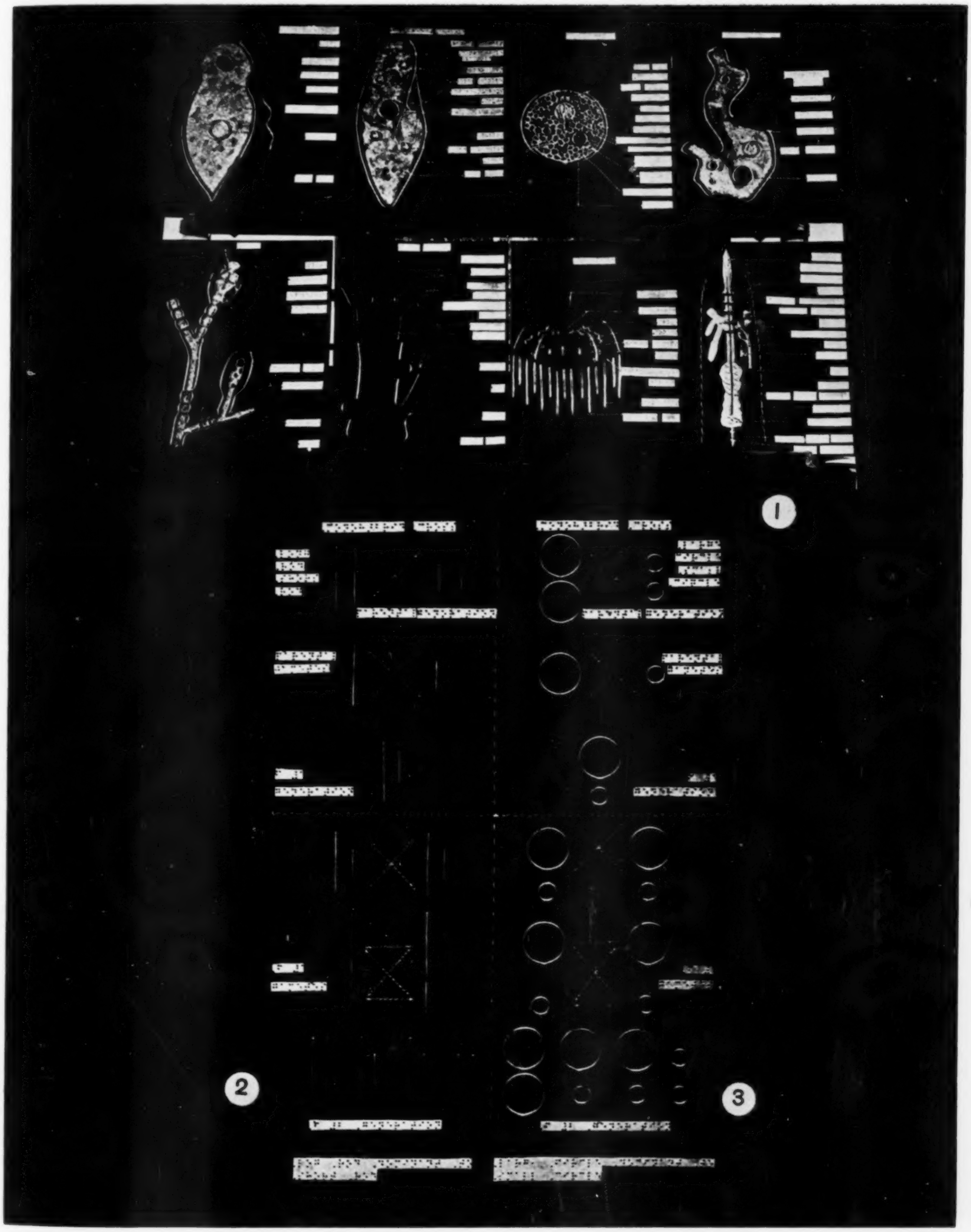
Our blind students attend lectures which they are as capable of taking down in Braille as is the seeing student by the more common methods. The text book is read to them, sometimes by kindly disposed students or by readers provided by various societies or clubs. They, of course, have no difficulty in taking part in the discussions that are held each week between the instructor and small groups. Now with these outline drawings done in wire and labelled in Braille, the writing of the blind, they have a chance to correlate the various materials that have been presented to them. Animals such as the Echinoderms, Arthropods and many vertebrates firm enough to be handled need no substitutes. It was surprising to me that after having been guided through the dissection of a frog they have been able to repeat the dissection and to identify parts as small as the pancreas. Moreover their dissections were carried out on four-inch frogs.

Examinations, of the "fill in" or "true or false" types, are read to them and filled in by the instructor as they dictate. Essay examinations are written out on their typewriters. In our experience our blind students, taking the same examinations as the regular students, pass them as a rule with B or even A grades.

It is natural that these students should take a little more of the instructor's time than those with normal vision, but their interest, the worth-whileness of the effort and their very sincere appreciation seem to justify the time required.

Mendelism, which was anticipated as a real stumbling block, proved easiest of all. Hereditary traits were represented as long and short rods and large and small circles. The larger figure was indicated as dominant to the smaller. In the dihybrid cross involving two characters a Punnett square was made of 16 small boxes to hold the genes representing the zygotic combinations. Four small boxes were fastened both across the top and down the side of the square. These small boxes contained the gametic or germ cell possibilities in long rods and circles, and the combinations resulting from the union of any two germ cells could be checked

Continued on Page Thirty-four



"DRAWINGS" IN WIRE, LABELED IN BRAILLE

1. TOP ROW, *left to right: Euglena, Paramoecium, Typical Cell, Amoeba.* BOTTOM ROW: *Obelia, Hydra, Medusa, Anterior End of an Earthworm.*

2 and 3. Wire diagrams used to demonstrate the laws of Mendel. Long rod is dominant to short rod and large circle is dominant to small circle.

Modern Chemical Warfare

• By Gerald C. MacDonald, B.Ch.E.
DEPARTMENT OF CHEMISTRY, ST. FRANCIS COLLEGE, BROOKLYN

How gullible is the public?

What is the truth about chemical warfare? Can New York City be destroyed in a few minutes by poison gas? Will bacteria be used as an offensive weapon in future wars?

Professor MacDonald answers these and many other questions.

As a commissioned officer in the Chemical Warfare Service of the United States Army he has contact with the best sources of information. His ideas will interest you.

Wars and threats of wars in Europe and Asia and Africa, regrettable as they are, cause much speculation as to what nature the fighting may assume. Because of the wide contacts which our high school teachers must maintain, it is imperative that they be properly equipped to discuss intelligently the modern developments in chemical warfare. The erroneous declarations of popular writers imbued with spectacular notions about gas warfare and the tendency of the press to exaggerate its sensational features make this requirement for our teachers all the more necessary, since our great non-scientific group has no other convenient means for obtaining information.

Popular Writings

Horror appears to be the theme of current articles on the use of chemicals in war, and the pity of this is that the reading public is very likely to accept the most sensational statements as though they were based on undisputed facts and announced by outstanding authorities.

Paul D. Gesner in *Forum*, October, 1931, presents a vivid picture: "Life does not exist in New York City today. Its millions of inhabitants lie dead—their lungs burned away by diphenylchlorarsine dropped from coalition planes in the air raid." In the quiet of his study Mr. Gesner evidently has discovered most remarkable properties for diphenylchlorarsine, properties which were unknown yesterday, and probably today, to anyone in the chemical profession. What the public does not know is that instead of being imbued with a spirit of horror when reading such material, it should find itself laughing. Diphenylchlorarsine, $(C_6H_5)_2AsCl$ is the old German agent, Blue Cross, so-called because the shells containing it were so marked for identification. It was used, not at all successfully, as a "sneeze gas," the theory being that, when used, it would not be adsorbed by the carbon in the canister of the gas masks, since it was a smoke of relatively large particle size. The theoretical result of the use of the gas was to be the removal of the mask because of intense nasal irritation, whereupon a lethal gas which had been disseminated concurrently would become effective. The lack of success in its use was due to the fact that because of the large particle size it did not penetrate the masks as well as was expected; further, the introduction of a filter pad into the canister effectively combatted its use.

Vedder, in *The Medical Aspects of Chemical Warfare*, states, "It is highly improbable that death will be caused by the use of these materials under field conditions." But such indisputable facts do not disturb our current writers; in the same month of the same year Emil Ludwig writing for the *Saturday Evening Post* stated, "If a certain kind of diphenyl chloral arsenic is mixed with air in the proportions of 1 to 10,000,000 its victim is compelled to throw off his gas mask, whereupon a deadly follow-up gas chokes him. People will be surprised in their sleep, and when they try to rise and reach for some support, they will begin vomiting and will fall unconscious, finally dying in convulsions." A minor detail overlooked by the eminent biographer was the fact that the American gas mask affords complete protection against diphenylchlorarsine. Had he been acquainted with fact, he might have made the statement that without some months of warning, and assuming that sufficient concentration could be attained, almost any lethal agent by itself would be effective in America, since money has never been appropriated by Congress to equip completely even our regular army—to say nothing of the civilian population—with gas defense equipment.

Again in the same discussion, the writer states that if an airplane dropped two large bombs of Lewisite gas over Chicago or Berlin, the populace in these cities would be wiped out. As a humorous sidelight we might calculate the size of the bomb required for partial completion of this tactical enterprise. Inadvertently, of course only inadvertently, the author neglected to do this. In order to neutralize an area of 10,000 square yards under average conditions, about 200 pounds of Lewisite is required. The area of the city of Chicago is 209 square miles or 647,398,400 square yards. The large bombs of which Mr. Ludwig speaks must each contain 32,370 pounds of Lewisite! And even if two such bombs could be carried by a plane, how the charge could possibly be disseminated over 209 square miles of area is gracefully left to the imagination. The chemical bomb in general use at present is the thirty-pound type.

The writer recently demonstrated the deadly effect of one of the popular agents of the fiction writer. At the close of one of his lectures, he supplied the hall with a copious quantity of gas, plus a dilution of tear gas, to make the lecture more "emotional." He has yet to hear of any casualties.

The writer is strongly averse to using the expression "humane" in a discussion of war materials. When one discusses war, one is considering a state of insanity that is inherently inhumane, regardless of how it is carried on. But, since many of our literary contemporaries have made a distinction between what they consider humane methods of warfare, such as disemboweling a man with a crude weapon, and the inhumane methods which attain the same end with a more refined weapon, the writer stifles his repugnance to such usage, and makes the statement that *warfare by means of chemicals is the most humane that has ever been developed.*

That statement is based on a number of statistics, a few of which I shall quote. By data taken from the Official Report of the Surgeon General of The United States Army on the casualties during the World War, we find that of the 224,089 total casuals admitted to hospitals, 33% were gas casuals. Of these only 1,221 died, whereas of those wounded by other weapons, 12,470 died. Only one and a fraction per cent of those suffering from gas effects died, and over eight per cent of those suffering from other wounds died. Even more startling are the statistics which include those who died on the field. Including those not admitted to hospitals the number of casualties was 258,338. 70,752 of these were caused by gas; and of this number less than *two per cent* died. 187,586 were caused by other weapons and of this number *twenty-four per cent* died. With reference to the after effects of gas, in the year 1918 there were one and one-half times as many cases of tuberculosis among the troops in France as there were among the gassed, and in 1919 there were one and three-quarter times as many among the ungassed as among the gassed.

Further, in response to a questionnaire sent out by the Chemical Warfare Service of the U. S. Army and published by the *Journal of the American Medical Association,* physicians in the United States and Europe who had contacts with gassed patients were almost unanimous in their opinion that no detrimental effects were observed as an aftermath of wartime gas.

Current literature closely associates the use of bacteria with chemicals. Let us consult an authority on this topic. Referring to *Bacterial Warfare,* by Major Lewis A. Fox, Medical Corps, U. S. Army in the *Military Surgeon* for March, 1935, we observe that whether or not such agents will be used depends upon their practicability rather than on sentiment, and that indicative of their present unsuitability we find, "(a) The effects of bacterial injury cannot be limited or localized; (b) Modern water purification methods protect against the organisms of typhoid and cholera; (c) Plague is a disease that would be as dangerous for the force using the organisms as for the attacked; (d) The danger from typhus has been exaggerated; (e) Modern sanitary methods are effective in controlling communicable diseases."

Classification of Chemical Agents

The expression "chemical agent" is used since the term "gas" is not strictly applicable. In their ordinary state most of these compounds exist as solids or liquids. Agents may be classified according to either their physiological or their tactical effects. In this article we shall confine ourselves to a classification of these agents based upon physiological effect.

1. *Lung irritants:* Those agents whose principal effects are on the lungs and respiratory passages. Examples: chlorine, phosgene, and chlorpicrin ($C\ Cl_3\ NO_2$). It may be interesting to note that chlorpicrin is four times as toxic as chlorine, which was the lung irritant first used by the Germans at Ypres in the World War; and that phosgene is practically ten times more toxic than chlorine.

2. *Vesicants:* Agents, which in addition to a lung irritant action, also have a blistering action on the body. Such are: mustard, $(ClC_2H_4)_2S$, and Lewisite ($ClCH:CHAsCl_2$).

3. *Lachrymators:* So-called tear gases; such as, chloracetophenone ($C_6H_5COCH_2Cl$) and brombenzylcyanide ($C_6H_5CHBrCN$).

4. *Irritant smokes:* These agents depend for their effect upon the inhalation of fine solid particles of the respective substances. They cause sneezing, coughing and, in sufficient concentration, vomiting. The name of sternutators is occasionally applied to this class. We have here, diphenychlorarsine, and diphenylaminochlorarsine $(C_6H_4)_2HN:AsCl$.

5. *Screening smokes:* The only physiological effect of these agents is the possibility of severe burns. They are used primarily because of their obscuring power. Under this heading we include white phosphorus, hexachlorethane mixture (C_2Cl_6, Zn, ZnO), titanium tetrachloride ($TiCl_4$), and chlorsulphonic acid ($HOSO_2Cl$). The latter gives the greatest volume of screening smoke at the lowest unit cost.

6. *Nerve and blood poisons,* such as CO and HCN. Up to the present time these substances have not been successfully used in the field.

A distinction based on the length of time that an active concentration will remain at the point of release is also necessary. If the remaining concentration, under conditions favorable for the use of that agent, is sufficiently great at the end of ten minutes to require protection of any kind, that substance is said to be a persistent agent. When no protection is needed under the above conditions, the agent is said to be non-persistent. Persistent agents are mustard, Lewisite, chlorpicrin and a tear gas solution consisting of chloracetophenone, chlorpicrin and chloroform. The term persistent is not at all a satisfactory one as the degree of persistence varies so much and is so dependent upon atmospheric conditions. The distinction in this case is analogous to that between volatile and non-volatile liquids, if one fails to mention vapor pressure.

Tactically the agents are grouped as: screening, harassing (lachrymators, etc.), casualty and incendiary. The terms are self-explanatory.

Chemistry of Chemical Agents

In the United States the research and development activities on these war agents is almost entirely centered at Edgewood Arsenal, Maryland. The staff is largely civilian and is under the direct supervision of the Chief of the Chemical Warfare Service of the Army. Although the regular Army has an excellent opportunity to build up a competent research and development group among its commissioned personnel by commissioning in the regular service outstanding R. O. T. C. graduates of the Massachusetts Institute of Technology Chemical Warfare Unit, no provision has yet been made to do so; thus a large amount of the research work is necessarily performed by civilians.

An element or compound suitable for combat purposes in the field must fulfill certain physical, physiological and chemical requirements. It must be very toxic, very irritant, produce a large volume of smoke, or have incendiary properties. It must be stable in storage and not too easily hydrolyzed. Large-scale manufacturing must be possible and raw materials for its manufacture must be available in continental United States. The agent must be suitable for loading in munitions and should have little or no corrosive effect on ordinary steel. The substance must be capable of vaporization or other means of dissemination in sufficient concentration under field conditions to produce the effect desired; and, finally, if the substance is a gas under ordinary conditions, it must be easily compressed to a liquid and easily vaporized when the pressure is released. You may observe at this point why it is that carbon monoxide and hydrocyanic acid are not satisfactory agents.

In addition to the absolute requisites mentioned, there are certain additional properties which are highly desirable, such as that of being capable of cheap and rapid manufacture in existing types of equipment, easy to handle, and with a density considerably greater than that of air.

It is not within the scope of this paper to describe in detail the commercial methods for preparing chemical warfare agents. In general their production is intimately tied up with the facilities which a country possesses for peacetime chemical industry. With the exception of chlorine, smokes, and certain incendiary material, the agents which have been used and are likely to be used, are all organic compounds; hence, any plant equipped for large scale organic synthesis, such as dyestuff manufacturing, is a potential producer of wartime material.

The intimate connection existing between chemical warfare agents and peacetime products may be demonstrated by considering a few: Chlorine, the first chemical agent used, has common commercial properties familiar to the freshman student of chemistry; chlorpicrin, a persistent agent, with both lachrymatory and irritant properties, is well adapted to the killing of the weevil and other insect destroyers of grain; phosgene is used in the synthesis of dyestuffs; tear gases which have no harmful properties have been used effectively in the dispersion of disorderly crowds, preventing in many instances a regrettable list of hospital and mortuary cases.

Protection Against Chemical Agents

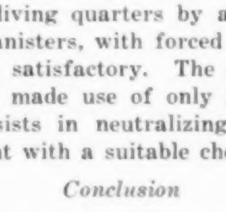
Protective devices may be divided into three types: those which exclude the agent from contact with portions of the body which may be affected; those which exclude the agent from living quarters; and those which neutralize the agent.

In the first category the modern mask is effective against lung irritants, sternutators, lachrymators and irritant smokes. The smoke is filtered out mechanically in the canister. The vapors and gases are adsorbed by activated charcoal or taken up by soda-lime. The protection required against a vesicant is protective clothing. Such protection at present is not as satisfactory as might be desired, since suits which exclude all gases in the surrounding atmosphere tend to smother the individual if worn for a protracted period of time. The recent tendency has been to try to impregnate ordinary wearing apparel with a neutralizing agent which will counteract the penetrating effect of the vesicant.

The second type of protection consists of excluding an agent from living quarters by admitting air only through large canisters, with forced ventilation. This method is fairly satisfactory. The final type of protective device is made use of only against persistent agents and consists in neutralizing the terrain covered by the agent with a suitable chemical.

Conclusion

It appears probable that the civilian population of this country has little to fear from chemical and bacterial methods of attack if they may rely upon a *properly provided for* scheme of defense. The words "properly provided for" are used, for the writer is well acquainted with the historical fact that the United States Government is prone to prepare schemes of defense but never to provide adequately for their complete execution. It *might* be of interest to note, and it certainly *should be* of interest to a citizen to know, that our land defense, as at present equipped, is practically defenseless against an attack involving the use of chemicals. Although no single plane carrying chemical munitions could seriously affect large centers of population, it most certainly could cause serious embarrassment to an air-post or coast defense work with the equipment at present available.



How Earthquakes Are Recorded

• By Reverend Joseph Lynch, S.J.
HEAD, DEPARTMENT OF PHYSICS, FORDHAM UNIVERSITY

The earthquakes which have been felt recently in numerous sections of the United States have drawn attention to the considerable number of seismographs located at Catholic colleges and universities as well as to those maintained by other institutions. People are curious to know how these instruments are constructed and how they operate. This article is, therefore, especially timely.

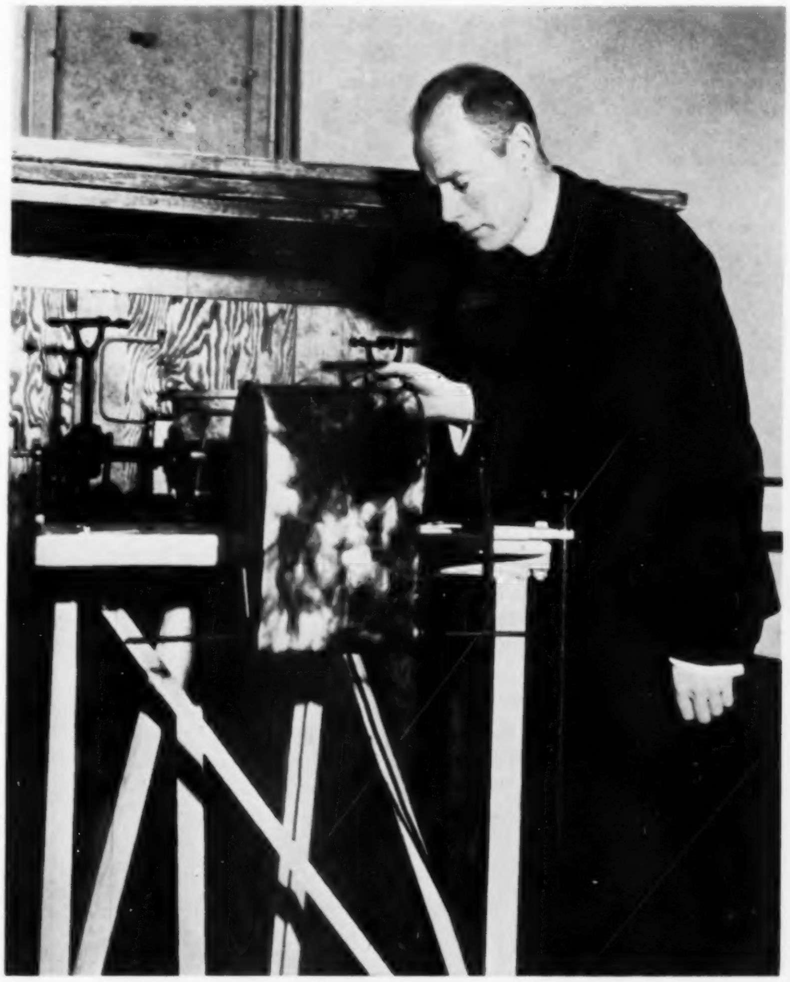
Father Lynch, an expert in seismology, writes entertainingly of his specialty. He uses a "popular" style.

A lady leaving a theatre after a popular lecture on astronomy was overheard to exclaim to her companion, "But the most marvelous part of astronomy, to my mind, is how they were ever able to find out the names of all the stars." To many people it seems equally marvelous that at an earthquake observatory we are able to locate an earthquake almost as soon as it occurs. Yet in reality the location of an earthquake at an earthquake observatory is no more marvelous than the discovery of the name of a star by the one who gave it that name. The location of earthquakes at an observatory is like the water falling over Niagara. What's to prevent it?

Some time ago, we read of the unfortunate sinking of the Nantucket Lightship by the White Star Liner Olympic. The Olympic was being guided to the lightship by radio waves. Nowadays, a ship can be quite definitely located by radio shore stations if she continuously sends out radio signals as the Nantucket was doing. In a similar way an earthquake can be located at earthquake observatories by the waves it sends out. The earthquake corresponds to the ship at sea constantly transmitting waves. The observatories correspond to the shore stations which pick up these waves and from their direction locate the quake.

An earthquake is a sudden shifting of a part of the earth's crust. This shifting may take place near the surface or it may take place a hundred miles or more down in the crust. But wherever it takes place, it jars the nerves of mother earth and sends a quiver throughout her system as a blast of a stone quarry causes the ground in the neighborhood to quiver. This quivering of the earth might be likened to the quivers or ripples on the surface of a pond when a pebble has disturbed its waters. The quivers travel throughout the entire earth as the ripples travel over the entire surface of the pond.

The question arises—how can these quivers be detected? They are too small to be seen and too feeble to be felt by the unaided senses. The seismograph is the instrument designed to detect and magnify these quivers. Its principle is very simple. If an ordinary playing card be balanced on the middle finger and a penny placed on top of the card, the card, without any practice, can be flicked away, leaving the penny on the finger. The card must be flicked quickly. The penny stays on the finger because of its inertia—a Latin name for laziness. It refuses to be hurried away as the card was, and it stays there. When an automobile starts up suddenly, the passengers lurch backward because of



Father Joseph Lynch, S.J.

their inertia—they refuse to be hurried and the car starts off momentarily without them so that they lurch backward in the car. Actually, they stay still while the car moves from under them as the penny stays still while the card moves from under it. When the brakes of a car in motion are jammed on suddenly, the passengers lurch forward because of their inertia. In this case, they refuse to have their motion stopped so that when the car stops they continue forward. All bodies possess this inertia and the heavier a body is, the more inertia it possesses. Inertia shows itself as a resistance to motion. If a body is at rest it wants to stay at rest. If a body is in motion, it wants to stay in motion. We hate to go to bed but when we are there, we want to stay there. This is the principle of the seismograph—because of its inertia it stays still while the ground underneath it moves.

A seismograph is a pendulum with its tip resting gently on the ground. When the ground underneath the pendulum quivers, as it does in an earthquake, the pendulum, because of its inertia, refuses to quiver so that if the ground moves slightly towards the right, the pendulum stays still, and, relative to the earth, appears to move to the left. If the tip of the pendulum be resting in loose sand, the relative motion of pendulum and earth will be traced out in the sand. This was the arrangement in the early types of seismographs. An ordinary pendulum was suspended so as to have its tip resting in loose sand on the ground—the motion of the ground would then be traced out by the pendulum in the sand. As each new quiver was traced out in the sand, the figure on the ground became very complicated.

To avoid this complication the next improvement was to have the tip of the pendulum resting not on the ground but on a sheet of paper covered with lampblack. This paper was wound on a drum which was kept revolving by clockwork under the pendulum. With the ground at rest, the tip of the pendulum would scratch in the lampblack white lines caused by the paper on the drum moving continually forward under the pendulum. If the earth quivered, i.e., if an earthquake occurred, the drum, since it is attached to the earth, would also quiver, and this quiver would be traced out in the lampblack as a sideways motion due to the sideways motion of the drum under the tip of the pendulum.

The pendulum is so suspended that it can only move from side to side. If two such pendula be placed one facing north and south and the other east and west, they will between them pick up any quiver from whatever direction it may come.

The motion of such a simple pendulum will, of course, be very slight, particularly if it is some distance from the scene of the quake. To magnify the motion so as to make it more visible, several devices have been introduced. In one instrument, the tip of the pendulum instead of resting on the smoked paper directly, is attached to the short arm of a lever—the tip of the long arm resting on the smoked paper and acting as the pen.

Other and better instruments do away with the smoked paper altogether and substitute for it sensitized photographic paper. The pen in this case is a tiny beam of light reflected from a mirror attached to the end of the pendulum—a motion of the mirror causing a motion of the beam of light over the photographic paper. This optical lever is a big improvement over the mechanical lever previously mentioned. The most sensitive types of seismographs have a coil attached to the end of the pendulum, two powerful magnets being set up on either side of the coil—each quiver of the coil in the magnetic field generating a current which moves the mirror of a galvanometer, the mirror in turn

Continued on Page Twenty-two

Seismographic Instruments at Fordham University

The Sound Film In Chemistry

An Experiment.

● **By Maurice U. Ames**
CHAIRMAN, DEPARTMENT OF PHYSICAL SCIENCE
GEORGE WASHINGTON HIGH SCHOOL, NEW YORK CITY

Teaching methods are subject to constant scrutiny. The old must give way to the new whenever the modern method can prove its superiority. Here the searchlight of scientific inquiry is turned on the desirability of using sound films in science instruction. The report of this careful study is interesting.

With Bernard Jaffe, Dr. Ames has recently published an excellent manual, "Laboratory and Workbook Units in Chemistry."

●

How much place are we going to give to films, and in particular to sound films in our high school courses in chemistry? During last semester a one-reel sound film called "Oxidation and Reduction," produced by Erpi Picture Consultants, Inc., for the University of Chicago, was tested as a teaching device for this topic in chemistry. This film was produced under the supervision of Professors Schlesinger and Lemon of the Physical Science Department of the University of Chicago. It is, undoubtedly, a fine piece of work.

Ten classes at the George Washington High School in New York City were made part of this experiment. These classes had registers of approximately 35 to 40 students of both sexes. Three of these classes consisted of students who had not studied or who were not then studying chemistry. The seven other classes were regular Chemistry 1 or beginning chemistry groups. Two of these seven Chemistry 1 classes were the control groups who were not to see the film. There were, therefore, three sets of groups, namely, the non-chemistry film group, the chemistry film group, and the chemistry non-film group.

All groups were given a series of three tests. A pretest was given on March 22 before the film was shown. Teaching the topic of "Oxidation and Reduction" by sound film or otherwise was to be confined to two periods of approximately 45 minutes each, one period on March 25 and one on March 26. The non-chemistry film groups were merely to be shown the film. The chemistry film groups were to be shown the film and taught by their teachers in various predetermined ways during the rest of the available time of these two periods. The chemistry non-film groups were to be taught the topics of oxidation and reduction during these two periods by the usual methods. On March 25 and 26 this was done. The film groups were shown the film at least twice, and in most cases three times. On March 27 all ten classes were given a mastery test on the topic of oxidation and reduction. Five weeks later, on April 30, all ten classes were given a retention test. The pretest, the mastery test and the retention test were identical. (Of course the students did not know this in advance). They consisted of 70 factual questions and 40 interest questions of the objective type. It should be pointed out that the chemistry classes had been studying chemistry for approximately five weeks and had already learned something about the topic.

The objectives listed by the producers of the sound picture and which served as the objectives in teaching the topic were:

1. To study the characteristics of chemical change and the methods used by the chemist in interpreting chemical phenomena.
2. To understand the processes of oxidation and reduction as phenomena of chemical change.
3. To identify oxygen as the active oxidizing gas in air.
4. To become familiar with some of the commercial uses of oxygen.
5. To recognize the similarity between combustion and corrosion.
6. To learn about the oxidizing properties of elements other than oxygen.
7. To understand oxidation and reduction as phenomena occurring simultaneously.
8. To identify elements which act as reducing agents.
9. To become familiar with some of the uses of oxidation and reduction in the fields of science and industry.

The following test was given three times to all the students in the experiment.

Complete the following statements by supplying the word or words needed:

1. When a substance burns in air it combines with the ________________.
2. When phosphorus burns in air, in a jar, the volume or air (is increased, is decreased, remains the same) ________________.
3. When powdered iron is left in a jar of air sealed with water, the iron forms ________________ because it ________________ of air. The water is observed to ________________.
4. These experiments with phosphorous and iron show that air contains ________ of ________ by volume.
5. When substances such as phosphorus and iron combine with ________ of the air, the substance ________ weight, and substances called ________ are formed. The process described is called ________________.
6. Mercuric oxide is a ________ colored substance which is composed of the elements ________ and ________________.
7. This mercuric oxide can be decomposed by means of ________.
8. Iron is used in fireproofing modern buildings because (it cannot burn, it has a high kindling point, it is a metal) ________.
9. Burning may be defined as combination of a substance with ________ accompanied by the release of noticeable energy in the form of ________ and ________________.
10. Oxygen is prepared commercially from (mercuric oxide, potassium chlorate, magnesium oxide, manganese dioxide, liquid air) ________________.
11. An example of a controlled industrial oxidation is ________.
12. An example of an uncontrolled oxidation is ________________.
13. A fuel is used to supply ________ because it can undergo the chemical process of ________________.
14. An iron plate or door can be cut by a torch which burns ________ in an atmosphere of ________________.
15. Water is a compound of ________ and ________________. Water may be decomposed into its components by means of ________________.
16. In this decomposition of water ________ is collected at the anode or positive pole and ________________ at the cathode or negative pole.

17. In decomposing water the volume of __________ formed is __________ the volume of __________ formed.

18. A glowing splint thrust into a bottle of oxygen (smokes, goes out, continues to glow, burns brightly, turns black) __________

19. The lowest temperature at which a material begins to burn is called its __________

20. Copper foil reacts with chlorine gas to form __________. During this process energy in the form of __________ and __________ is released. This in an illustration of a chemical process called __________

21. The process that takes place simultaneously with oxidation is called __________. This process consists in the __________ from a substance.

22. When hydrogen burns in air or in oxygen __________ is formed.

23. Hydrogen can react with iron oxide to form __________ and __________. The iron oxide is said to be __________ by the hydrogen.

24. When a stream of hydrogen is passed over heated copper oxide, __________ and __________ are the products formed. Hydrogen is called a __________ agent

25. Helium is more satisfactory than hydrogen for inflating balloons and dirigibles because __________.

26. Iron is extracted from hematite ore by mixing the ore with __________ and limestone and smelting in a furnace called the __________ furnace. The substance undergoing the process of oxidation is the __________. The substance undergoing the process of reduction is the __________.

27. When aluminum reacts with iron oxide __________ is produced in the molten state. This reaction is used commercially in __________.

28. Magnesium will reduce carbon dioxide to form __________ and __________ as products.

29. Animals derive body heat and energy by __________ substances called __________

30. Write alongside the blanks of List A the number of the item in List B which corresponds. Do not write any number more than once.

LIST A	LIST B
a. Oxidation __________	1 Compounds of elements and oxygen.
b. Reduction __________	2. A glowing splint bursts into flame
c. Goldschmidt Process __________	3. Breaks up water into hydrogen and oxygen.
d. Water __________	4. Solid carbon dioxide.
e. Electrolysis of water __________	5. Uses coke as a reducing agent.
f. Test for oxygen __________	6. Removing oxygen from a substance.
g. Test for hydrogen __________	7. Aluminum is used as a reducing agent.
h. Dry ice __________	8. A compound of hydrogen and oxygen.
i. Blast furnace __________	9. A burning splint ignites the gas.
j Oxides __________	10. Combination with oxygen.
	11. Formation of carbon.
	12. Simultaneous reaction.

INTEREST QUESTIONS

To Students of High School Chemistry:

We are trying to find out the extent of your interest in the various topics of chemistry. If you follow the directions carefully and answer the questions honestly we may be able to make the chemistry course much more interesting.

This is NOT an examination.

Below you will find the set of questions. Read each question carefully and write in the space before the question the number

2 if you are VERY MUCH interested in the question, or

1 if you are SLIGHTLY interested in the question, or

0 if you are NOT interested in the question.

Remember, this is not a test, so do not try to answer the questions. Just write 2 or 1 or 0 to show how much the question interests you. Omit no questions and answer the questions as directed.

____ 1. Why does a metal get heavier when heated in the air?
____ 2. Why must we have oxygen in order to live?
____ 3. Is sodium a metal?
____ 4 Why does a zeppelin float in the air?
____ 5. Why does coal burn?
____ 6. What do the nitrogen-fixing bacteria do?
____ 7. Is chlorine an active element?
____ 8. How is sulphur dioxide used in refrigeration?
____ 9. What is bromine?
____ 10. What is the effect of the formation of gases in a chemical reaction?
____ 11. How can we make sodium hydroxide?
____ 12. How are numbers etched on glass?
____ 13. Why does sodium tarnish quicker than copper?
____ 14. Of what does mortar consist?
____ 15. What is bronze?
____ 16. What mineral contains phosphorus?
____ 17. Why does potassium react more readily with water than with iron?
____ 18. How do we make explosives?
____ 19. How can we calculate the amount of space occupied by five grams of carbon dioxide?
____ 20. What is Lavoisier noted for?
____ 21. Why do not all reactions go to an end?
____ 22. How can we extract copper from a copper sulphate solution?
____ 23. What is galvanized iron?
____ 24. How do we determine the molecular weight of a gas?
____ 25. How can we predict how much mercury will combine with oxygen to form mercuric oxide?
____ 26. Why do two hydrogen atoms combine with one oxygen atom to form H_2O?
____ 27. What is the difference between electrons and protons?
____ 28. How is hydrogen prepared commercially?
____ 29. What did the alchemists contribute to chemistry?
____ 30. Why are platinum containers used for acids rather than iron containers?
____ 31. Why do we find many minerals and very few pure elements?
____ 32. How does lead exist in nature?
____ 33. Of what does the atmosphere consist?
____ 34. What does molecular weight mean?
____ 35. What effect has temperature on the volume of gases?
____ 36. How is sulphuric acid prepared commercially?
____ 37. If the product of a chemical reaction is insoluble what effect has it upon the chemical reaction?
____ 38. How do we prepare iodine?
____ 39. How can we neutralize an acid?
____ 40. Which liquids do not conduct electricity?

The factual part of each test paper consisted of 70 completion questions. The maximum score on this part was, therefore, 70. There were 40 interest questions listed on each test paper. Each interest question was rated either a 2 or a 1 or a 0. The frequency of the occurrence of 2, 1 or 0 was recorded for each interest question and the average or mean interest score was thus computed for each question. The interest questions numbered 1, 2, 4, 5, and 7 were grouped together as being related to the film. The interest questions numbered 6, 8, 11, 12, 13, 17, 18, 21, 22, 24, 33, 36, 37, and 39 were grouped together as not being related to the film.

I have arranged most of the data, accumulated from the laborious job of grading almost one thousand test papers, in convenient tabular form. For the purpose of this article I have tried to make this data easily understandable. The results in the factual tests for the chemistry film group E seemed outstanding enough to warrant a statistical comparison with the other chemistry film groups A, B, C, and D.

I have also listed some conclusions for both the factual and interest material on which the students were tested. Possibly other and better arranged and controlled experiments along the same lines may show more striking results.

In any event there is need for more experimentation and the accumulation of more data in connection with the teaching of chemistry by means of films.

TABLE SHOWING WORKING SCHEDULE

Group	March 25	March 26
1. Non-chemistry film A	Film Film	Film
2. Non-chemistry film B	Film	Film Film
3. Non-chemistry film C	Film Film	Questions Answered Film
4. Chemistry film A	Film Lecture	Film Lecture
5. Chemistry film B	Film Recitation	Film Recitation Film
6. Chemistry film C	Group Activity Film	Film Dem. Exp't.
7. Chemistry film D	Film Recitation	Film Lecture Film
8. Chemistry film E	Lecture Film	Recitation Film
9. Chemistry non-film A	Recitation Dem. Exp't.	Group Activity, Dem. Exp't. Lecture
10. Chemistry non-film B	Recitation Lecture	Dem. Exp't. Group Activity

Note—To pupils of all groups the Pretest was given March 22, the Master test, March 27, and the Retention test on April 30.

GENERAL SCORE TABLE ON FACTUAL QUESTIONS

Group	Number of Students	Pretest Score (Mean)	Mastery test Score (Mean)	Retention test Score (Mean)
Non-chemistry Groups	93	17.56	36.33	32.23
Chemistry Film Groups	172	42.14	54.71	*55.11
Chemistry Non-film Groups	69	41.31	52.51	*54.51

*Note—During the five-week period between the Mastery and Retention tests, although no attempt was made to teach the topic of Oxidation and Reduction, both the chemistry film and the chemistry non-film groups had been studying more chemistry.

GENERAL SCORE TABLES ON INTEREST QUESTIONS

		Questions Related to Film Average Score	Questions Not Related to Film Average Score
Non-chemistry Groups	Pretest	1.29	1.07
	Mastery Test	1.32	1.18
	Retention Test	1.19	1.05

		Questions Related to Film Average Score	Questions Not Related to Film Average Score
Chemistry Film Groups	Pretest	1.39	1.34
	Mastery Test	1.39	1.27
	Retention Test	1.32	1.24

		Questions Related to Film Average Score	Questions Not Related to Film Average Score
Chemistry Non-film Groups	Pretest	1.33	1 19
	Mastery Test	1.29	1.23
	Retention Test	1.16	1.11

Statistical Comparison of Gains of Chemistry Film Group E and Gains of Chemistry Film Groups A, B, C and D.

Group	No.	Gain (Mastery test minus pretest)	Standard Devia-tion	Differ-ence	Standard Error of Differ-ence	Signifi-cance Ratio
E	35	14.29	6.2	2.00	1.2	1.7
A, B, C, D	137	12.29	7.3			

Group	No.	Gain (Reten-tion test minus pretest)	Standard Devia-tion	Differ-ence	Standard Error of Difference	Signifi-cance Ratio
E	35	16.05	7.0	3.84	1.3	2.9
A, B, C, D	137	12.21	7.7			

Continued on Page Thirty-three

The Place of General Science in the Integrated Science Curriculum

By Louis E. Welton
ASSISTANT PRINCIPAL, JOHN HAY HIGH SCHOOL, CLEVELAND

When science teachers discuss the value of a high school course in general science the discussion is likely to become somewhat heated, for this is one science about which there are a number of conflicting opinions. Should it be taught at all? What are its aims? How can they be accomplished?

Dr. Welton is one of the co-authors of the new textbook of general science, "Exploring the World of Science" and of "A General Science Workbook." He believes that "General science should be the keystone in the science structure of the elementary grades. At the same time it should become the corner-stone of the science structure for the solution of the problems of everyday life and for future work in science."

Because general science is a definite part of the integrated natural science curriculum, the first question to be considered is, "What is the purpose of teaching natural science?" Of course the teaching of natural science must contribute to the general aim of education, that is, to give every individual in so far as his native ability allows, the necessary knowledge, habits, attitudes, and skills so that he may make the most complete adjustment to his environment. This adjustment implies the highest type of unselfish citizenship.

What contribution then can the teaching of natural science make to the general aim of education? The teaching of natural science should give every individual, (1) the right attitude toward personal and community health, (2) the ability to interpret natural phenomena, (3) a respect for truth (tested knowledge) and a willingness to accept it, (4) a functional appreciation of the use of science in our modern civilization, and (5) the ability to use intelligently the machines which science has given him to alleviate human drudgery.

A knowledge of natural science raises man from the superstitious, ignorant savage to the courageous, intelligent individual of civilization. The savage fled before the approaching darkness of a total eclipse of the sun and prayed to his pagan gods for deliverance. The layman today gazes upon this strange phenomenon with true appreciation of its cause and the full assurance that the sun will soon reappear. The scientist makes elaborate preparations for its study to gain more knowledge for mankind. It is needless to point out further differences in the behavior of the savage and the educated man due to their adjustments to their environments. A knowledge of science should create in man a desire to seek the truth and base his conclusions upon it. Natural phenomena are no longer mysteries. The educated man is freed from superstition. In his business, in his home, and in public life he is guided by the desire to know the facts in every situation. He respects truth and refuses to accept any substitute for it.

In order to gain these objectives of science teaching, what are some of the outstanding factors in the problem of science education? The term science education as used here implies a purposefully integrated science curriculum from the kindergarten or first grade through the high school. With the same point of view it may be projected through the college and university.

Of course, the first and most important factor in science education is the individual, the pupil. We shall grant that every pupil except the imbecile and low grade moron is capable of making some progress in the acquisition of the knowledge of science. While individuals may vary greatly from one another in separate groups, the great mass of children remains about the same from one generation to another. The best in euthenics and scientific feeding and care seem to indicate that individuals and consequently the whole group can be improved. However, as this prospect lies far in the future, this discussion will be based upon the boy and girl as they are in our schools today. Science teaching must care for each individual according to his specific needs, aptitudes, and abilities.

The next factor is the teacher. The science teacher of today is better prepared for the duties of teaching than ever before. Colleges and universities are extending their facilities for teacher training and the teachers in turn are taking advantage of these opportunities. Such organizations as the National Society for the Study of Education publish reports on the philosophy and practice of teaching which make it possible for teachers to keep abreast with the best thought in education. Reports of researches made by health associations and industrial corporations are continuously increasing the body of subject matter available for science teachers. By taking advantage of these educational opportunities, the science teachers in our schools today have reached a high standard in preparation. It is needless to point out that the standard of science teaching will be raised in proportion to the number of teachers taking advantage of these educational opportunities. The enthusiastic teacher with a full knowledge of science is a vital factor in science teaching.

Another factor in the problem of science education is a group of materials which may be called the tools

Continued on Page Twenty-five

Some Practical Observations on

The Teaching of General Science

• By W. R. Teeters
SUPERVISOR OF PHYSICAL AND BIOLOGICAL SCIENCES, PUBLIC SCHOOLS, ST. LOUIS.

The teaching of general science presents difficulties that are peculiar to the subject, as well as others that are common to the other high school sciences. Dr. Teeters has learned of these difficulties by first-hand contact. Here he graciously sets up warning signs to guide and instruct the less experienced.

He discusses teacher preparation, courses of study, textbooks, equipment, and other practical points.

A review of the new book of which he is co-author, "Science at Work," by Regenstein and Teeters, appears in this issue of THE SCIENCE COUNSELOR.

●

When school opened this fall thousands of boys and girls had their first introduction into general science, a subject which has developed from a series of short courses in the various individual sciences to the well-balanced, integrated course of today. This course now presents science as a means of solving problems of individual and community importance. Its emphasis is not placed on the learning of a number of laws and on the solving of abstract problems. No longer can the teachers of the individual sciences legitimately say that general science robs their particular subject of interest by presenting its high lights.

In spite of the fact that schools of education have made every effort to bring about an ideal course in general science and have trained teachers capable of teaching the subject successfully, there are many schools where the course lacks development and organization, and where it is poorly presented. Various reasons can be cited as to the cause of such a condition. Among them may be mentioned the fact that many teachers who do not have the background for such work are called upon to conduct courses in general science. In some schools teachers have been, and still are, called from every department to take classes in general science either to fill out their programs, or to act as a utility teacher to help out the principal. When such conditions exist, obviously almost anything can happen. Generally the students and teachers work together using their textbook as a course, and both get something in return for their efforts. The teachers in such cases, however, can do little more than guide; and sometimes the guiding is not expertly done.

Another unsatisfactory condition, more prevalent than the one just mentioned, exists where the teacher is prepared in only one science. Physics teachers, biology teachers, or chemistry teachers are given classes in general science. Too often in such cases the course becomes a course in physics, or chemistry, or biology. The science teacher who has a background in some branch of science and who really is interested in teaching general science, if he cares to do so, can overcome his desire to teach his original major. With some extra work and study from time to time, he can develop into a first class teacher of the general subject. It is the opinion of the writer that general science is the most difficult to teach of all the sciences which are offered in the high school curriculum. It requires a broad background of all the sciences, a background which few teachers had at the time the subject was introduced. Many of the older teachers have developed into superb teachers of general science, and new teachers are now being graduated from the various universities who can do the work well and efficiently. The teacher who knows his work, who can lead and inspire the student, is a great asset both to his school and his community.

In higher institutions of learning courses now are being offered where teachers receive instruction in the subject of general science—especially in the content material, which generally is the weak point. For those who are not able to attend the universities, much help can be found in current scientific publications and such books as the "Nature of the World and of Men" published by the University of Chicago Press. It is helpful, also, for the older teachers of general science, or for those who, due to curriculum and program adjustment, find themselves forced into the field of general science, to study some of the recent texts which are now used in the college course. Texts in the separate sciences are available in libraries, or can be obtained from publishers at reasonable prices. The purpose of this extra study is not that the teacher shall try to teach what is found in such texts; the residue of learning left with the instructor after the mass is forgotten is invaluable.

Much has been said and done about courses of study. Selected committees all over the country have worked diligently and at an enormous cost, preparing courses incorporating all the best ideas of the schools of education. Yet these courses do not always work well in the field unless various sets of textbooks and a comprehensive library are at hand. The writer has found that one of the most satisfactory ways of providing a comprehensive and adequate course in general science is to select a good basic textbook—and there are many—and write a syllabus based on the selected text. Obviously a course adequate for a large city school would not necessarily fit a small rural school. Textbooks are sufficiently comprehensive to permit a course of either type. The syllabus guides the teacher, showing what

to take and what to omit. It takes care of the amount of work that can be done during the school year, for high schools vary in length of school year from seven to ten months. The syllabus, based on the text in use, concentrates the pupil's attention. He need not look through a half-dozen books in attempting to form a conclusion when he can get the required information from his own text. This does not mean that reference books should not be employed; but trying to follow a course of study which calls for various textbooks in the subject is confusing to the student at the level of the eighth and ninth grades. Further, the syllabus organizes the work in a general way, yet it does not take all the time available for the course. This gives the teacher an opportunity to use his own individuality and expand certain fields in which he is interested without detrimental effect on the course as a whole.

Because of the present economic conditions there has been a general move to increase the number of pupils per class. Perhaps the average-sized class in general science is now forty, as compared with thirty a few years ago. Of course, classes still exist with an enrollment of thirty or even less, and some classes have an enrollment of more than forty. In the larger classes where no attempt is made to segregate pupils according to their I.Q. rating, the teacher is faced with a rather perplexing problem. He finds students of slow, average and high ability. The successful teacher must care for each group. This may be done by grading the material offered, the slow moving group merely mastering the bare fundamentals, the average group mastering the course as outlined, and the fast moving group having the course enriched by additional assignments both in reading and in experimental work. A skillful teacher can keep a mixed group working at its maximum by some such arrangement. Any recent text gives ample references, suggestions, and problems to aid the teacher in preparing work for any type of student who may not fit in with the average of the class. The course must be presented so that every pupil feels that he is doing something and is not overshadowed by others more alert than he. Each student must be challenged, must be made to feel the need of doing his best. This may be accomplished by the simultaneous three-way course in which each student is working to his capacity on his own level.

General science has been presented to students both as a laboratory subject similar to physics and chemistry, and as a classroom subject with demonstrations. The writer prefers the latter arrangement for two or three reasons. First, due to the pupil's lack of experience in laboratory work, he can best acquire a technique in handling apparatus by getting his first experience through watching a demonstration experiment expertly done. Second, the student will have an opportunity of learning to perform experiments and manipulate equipment from time to time by way of demonstrating a problem before the class. Third, the cost of the laboratory method over the demonstration method is great, and economy should be practiced so long as the welfare of the student is not jeopardized.

A great amount of equipment and supplies is not needed for general science. Much of the simple apparatus can be obtained from the home or created from material at hand. If funds are available, a limited amount of money can be spent profitably in purchasing selected apparatus and supplies which will aid materially in carrying on the work which the teacher has selected for the year. The room in which the class meets should be equipped with a demonstration desk having gas and water outlets. It is also convenient to have electricity at hand. With simple equipment the teacher can create a desire on the part of the pupil to remain in school and continue in science courses; or if it is necessary for him to leave school, he will go forth equipped with a well-rounded view of science which will be of great value to him in life.

The textbook naturally plays an important role in any subject, and especially is this true in general science. Most of the books in this field today are of a high type of excellence. A text should present the fundamental principles of science which are applicable to the problems which the student must solve in life. These are two-fold: First, those which apply directly to him as an individual; and second, those which apply to the community in which he lives. Some of the major problems which apply to the individual are those pertaining to food, clothing, shelter and health. These, in turn, can be broken into a number of minor problems which have direct bearing on the major problems. In solving the problems, the sciences which aid in the solution should be introduced. In this way the student becomes acquainted with each science. The same process can be applied to the problems of the community, such as community sanitation, water supply, milk supply, health service, fire protection, weather conditions, and the like. Here again the major problems can be broken up into minor problems, and the sciences applicable to their solution can be employed. A textbook following some such procedure is of the greatest value both to the teacher and the student. Such a text does not present any science as a formal subject, but introduces it where it is needed. A well-planned course in general science thus presented introduces all of the sciences and shows something of the fundamental application of each. General science never was intended to give definite training in physics, for instance, of the nature we should expect the student to obtain from a course in physics. The same can be said of any other single science. But general science does, when properly presented, open all of the doors of science and gives the student some idea of each. It gives him a fund of information upon which to draw should he wish to choose some science for further study.

A textbook should contain a list of various activities at the end of each unit. Such suggestions and helps are of service to the teacher in enriching the course for those pupils who are capable of doing more than the average. Testing activities aid in measuring the progress of the student. There is some difference of opinion among teachers as to whether the demon-

Continued on Page Twenty-eight

Unit Planning In Biology

• By Ivan G. Hosack, M.S., *(University of Kentucky)*
PERRY HIGH SCHOOL, PITTSBURGH.

The Editor considers this one of the most valuable articles that THE SCIENCE COUNSELOR *has been privileged to present. He regrets that limitations of space do not permit its printing in full in this number.*

In our March issue an actual biology unit will be studied. It will be selected from those now in use by Professor Hosack, and for convenience, it will be organized into a plan for the teacher and a plan for the individual pupil. It will provide a helpful and inspiring model not only for teachers of biology but for all science teachers.

●

PART I.

In our present-day secondary schools, teachers are more and more coming to see the relation of their work to the lives of those they teach. No doubt this emphasis on applications in everyday life has come as the natural result of the changes which have taken place in our school population and in our philosophy of education. Since 1914 our high school enrollment has increased over 20 per cent. When we compare the percentage of children between 10-15 years of age in gainful occupations today with those of 1914, we note a decided trend away from industry toward our schools. The percentage of children, in this age group in 1914, was over 15 per cent, while in 1930 it was 4.7 per cent. In 1929, as compared with 1930, the depression caused a decrease of 34 per cent of this age leaving school for work. This trend continues, the child remaining in school. This tremendous increase in the numbers of pupils in our secondary schools indicates that they are no longer educational institutions for the select few, but are becoming truly democratic institutions to which all who will may come. In general, educators are agreed that the function of the school is to make education accessible to the youth of our land and to make it adequate. In the words of one worker in the field of curriculum, "The ultimate aim of education at any level of intellectual attainment is the desirable modification or enrichment of life of the individual so as to enable him to make the greatest possible contribution to society and at the same time to gain personal satisfaction." If we accept this aim of education, it is evident that we must consider our biology courses in terms of the desirable modification or enrichment of life which should result from the study of biology, the science of life itself.

Prior to the planning of an actual unit or units in biology, to supply the basis of intelligent behavior, questions such as the following must be answered: (1) What objectives or aims will biology serve in bringing about desirable behavior? (2) What criteria should be the basis or bases for selecting materials for instruction? (3) Upon what basis or bases should the materials of a course in biology be organized? (4) How shall we provide for the individual differences of our pupils? (5) What are the best methods to be used in teaching them? And (6) how may we test or measure the products of our teaching? In determining answers to questions such as these, the reader is asked to bear in mind that: first, although various scientific studies have been made and tested to determine the real foundations on which to build our biology course, no panacea can as yet be offered for curriculum planning or for solving all our teaching problems; and second, that the writer must, of necessity, be brief because of the scope of the subject, and the limitation of space.

Objectives in Biology

During the past fifteen years, ever since the work of the committee on the Reorganization of Science, and the publication of its summary of the major objectives of science, various scientific studies have been made to determine the fundamental factors on which to build our biology, as well as other secondary science courses. These studies are contributing widely to answering the questions as to what attitudes, understandings and principles, habits and skills should be taught in biology and what should be eliminated. As the *first* step in unit planning, they should be studied thoroughly by teachers and curriculum workers in biology. As a result, they will become familiar with the biological knowledge, skills, and attitudes that the majority of individuals should have if they are to be individually and socially efficient in their status of life. A brief list of important publications, dealing with general problems of course making and specific teaching problems, is given in the bibliography.

As a *second* step, the biology teacher should consider the natural resources of the local community—as the home factors, the occupational factor, the pupil-interest factor, and the textbook and reference factor—before formulating objectives.[2] This data may be obtained from the teacher's observation and visitation, from pupils, from citizens who are well acquainted with the community, physicians, health officials, county or local agents, school records, previous studies of the community such as health surveys, etc. As a result, the teacher will be able to relieve the aimlessness of biology by setting up objectives that will consider the natural resources, predominant occupations, health, beautification, etc., of the community, as well as, the predominant lines of work into which pupils go after leaving high school.

Our *third* step may well consist of formulating such objectives, in keeping with our aim of education, that biology teaching should attempt to achieve at the secondary level. An excellent statement of the objectives or aims of biology is to be found in the Pittsburgh "*High School Course Of Study In Biology,*" formulated

in 1934, for experimentation, by a committee of biology teachers, under the guidance of Dr. D. R. Sumstine, Department of Curriculum Study and Research, and Dr. John A. Hollinger, Department of Science, Pittsburgh Public Schools. With the kind permission of Dr. Sumstine, the aims of this course of study are stated as follows:

I.—The development of worthy scientific attitudes.

A. A feeling of being a part of the great stream of life and a desire to contribute to the betterment of life in all its forms. Appreciation of the need for conservation of life.

B. Appreciation of and belief in
   1. Universal natural law; cause and effect relationships, discarding superstitions.
   2. Contributions of great biologists to civilization.
   3. Significance of biological science in modern social and industrial life.
   4. Importance and extent of biological vocations.
   5. Changing conceptions of biological truths.
   6. Natural beauty.

C. Desire for
   1. Objective thinking, honestly looking for concrete evidence, inquiringly and critically; suspending judgment with an open-minded respect for further evidence as well as for other's points of view, willingness to be convinced on the basis of objective evidence; interested in testing opinions and beliefs and reformulating opinions in the light of new evidence or of very careful inference.
   2. Healthful living.
   3. Making the best of leisure time by a sustained interest in
      a. Experimenting in the field of biology.
      b. Extensive reading in the field of biology.

D. Proper attitude towards and respect for life processes.

E. Realization that much remains to be discovered in the biological sciences with great possibilities for research and adventure.

II.—Skill in Scientific Thinking. This is to be developed (1) by becoming aware of the elements involved in scientific thinking, (2) by learning in advance what errors one is most likely to make in the use of the elements involved, and (3) by practice in problem solving.

It is convenient to recognize two types of problems: (1) those which are primarily inductive, or problems of discovery; and (2) those which are primarily deductive, or problems which are solved by applying known scientific principles. In the process of solving a problem it is recognized that it may take the form, at one time, of an inductive and, at another time, the form of a deductive problem. For the sake of clarity these two types are considered separately. (Thirty-First Yearbook, Part I, National Society for the Study of Education (1932) p. 234).[2]

A. The Inductive Method.

(Elements)	(Safeguards)
1. Purposeful observation.	(1) Must be accurate.
2. Careful recording.	(2) Must be extensive.
	(3) Must be done under a variety of conditions.
3. Analysis—synthesis.	(4) The essential elements in a problematical situation must be picked out
	(5) Dissimilarities as well as similarities must be regarded. Danger of analogy.
	(6) Exceptions are to be given special attention. Selective interpretation.
4. Selective recall.	(7) A wide range of experience necessary.
5. Hypotheses.	(8) All possible ones must be considered (fertility of suggestion).
6. Verification by inference and experiment.	(9) Inference must be tested experimentally.
7. Reasoning by:	(10) Only one variable permitted.
a. Method of agreement.	(11) Data must be cogently arranged.
b. Method of difference.	(12) Judgment must be passed on the adequacy of the data.
c. Method of residues.	
d. Method of concomitant variation.	(13) Judgment must be passed on the pertinency of data
e. Joint method of agreement and difference.	
8. Judgment.	(14) Must be unprejudiced.
	(15) Must be impersonal.
	(16) Must be suspended if data are inadequate.

B. The Deductive Method.
   1. Problematic situation arising from an hypothesis.
   2. Problem clearly defined.
   3. Analysis.
      a. Principles employed in deductive solution.
   4. Testing by recall of facts or by experiment.
   5. Conclusion and generalization.

III.—Understanding of Biological Principles, a knowledge of the facts pertaining to these principles, and drill in their application to life situations (Developed in detail in Thirty-first Yearbook, Part I, National Society for the Study of Education (1932) pp. 224-226).

A. Animals and plants are distributed uniformly or at random over the surface of the earth, but are found in definite zones and in local societies.
B. Organisms must be adapted to environmental factors in order to survive in the struggle for existence.
C. The cell is the structural and physiological unit in all organisms.
D. The ultimate source of energy for all living things is sunlight.
E. Neither energy nor matter is created or destroyed, but is merely transformed from one form to another.
F. Food, oxygen, certain optimal conditions of temperature, moisture, and light are essential to the life of most living things.
G. There is a complex web of life and an interdependence of organisms.
H. The struggle for necessities of life results in maintaining the balance of nature.
I. Micro-organisms are the immediate cause of some diseases.
J. There are processes that go on within an organism that are vital to its continued existence.
K. Irritability is a fundamental property of protoplasm and is especially well developed in certain cells, organs, or groups of organs called systems.
L. Behavior is intelligent when it shows that an organism has profited by experience.
M. All life comes from previously existing life and reproduces its own kind.
N. The greater the degree of parental care, the less is the need for a great number of eggs or of offspring.
O. The more complex organisms have been derived by natural processes from simpler ones, these in turn from still simpler, and so on back to the first living forms.[3]

In brief, the objectives stated above should provide: (1) biological data needed to solve the problems of life; (2) understandings necessary to provide the basis for behavior in many biological situations in terms of the important attitudes, skills, and principles of the subject; (3) development of the scientific attitude of mind; (4) ability to do critical thinking; and (5) development of intellectual interests and appreciations which make possible a desirable use of leisure time. As Dr. John A. Hollinger has so well stated: "Serious effort should be made to cultivate proper mental attitudes towards the objective method of thinking. Pupils should be given practice in the inductive method of dealing with objective data with an open mind, with intellectual honesty and integrity, with courage to face in an orderly fashion and to submit conclusions and beliefs to every possible objective test. Inferences should be carefully guarded."

Criteria for Selecting Materials for Instruction

If biology is to provide a basis for the solution of everyday problems in life, the criteria for selecting subject-matter materials should consider those of relatively greatest value. Such criteria have been well stated by Prof. Emery N. Ferris of Cornell University. He says:

Subject-matter should be selected on the basis of:
1. Its direct values in giving the pupil the knowledge, abilities, skills, appreciations, etc., desirable in the activities to which the objectives of the course pertain.
2. The relative number of individuals who will use the knowledge, skills, abilities, habits, etc., and
   a. The frequency of their use;
   b. The certainty of their use;
   c. Their importance when used.

3. Its adaptability to the learner's stage of maturity.
4. Its appeal to the learner.
5. Its requirement in terms of time and effort.
6. The degree to which it can be used in a natural setting.
7. The intimacy of its relationship with the other elements of the subject-matter used in the development of a topic, type, problem or project.[5]

On the other hand, the teacher is often faced with the problem of what subject-matter should be eliminated from the biology course. The following suggestions, expressed by Dr. William E. Cole, should aid us at this point:

1. All biological subject-matter which does not have some relation to the activities and interests of the pupils enrolled in the course, or the needs of the individuals living within the patronage areas of the school, but who are not in school.
2. Subject-matter of biology that is not reasonably within the pupil's comprehension, as indicated by common-sense evaluation, observation, experimental evidence, and the teacher's experience in teaching pupils.
3. Whatever is unlikely to appeal to the pupil's interest, unless there is urgent need for it, in which case the teacher will have to attempt to create an interest in the subject-matter.
4. Whatever is not useful to the majority of pupils within the course. Individual projects should take care of those phases of subject-matter which are valuable for only a few.
5. Whatever is being efficiently taught outside the school, or subject, or which cannot be efficiently taught within it.[6]

Organization of Materials for Instruction

Many high schools, a few years ago, offered a one-year course in biological science, one semester given over to the teaching of botany, and the last half-year to zoology. Some high schools added from one to two semesters of physiology and hygiene. Then a one-year course in general biology was substituted. This change in the organization of high-school biology courses has gone on steadily, until today, we find that few schools are teaching the old program. However, in many schools this general biology course simply amounted to a series of courses in the separate sciences formerly taught; plants, animals, and man were considered separately, with topical divisions of these groups. The general opinion today is that this organization is not satisfactory, as we are no longer interested in the descriptive side of biology, or trying to obtain an intelligent attitude toward crayfish, earthworms, paramecia, frogs, or algae. The change in our school population, makes it imperative that our course should develop concepts which will help our boys and girls to live intelligently in a world of science, rather than follow the general outline of courses given in colleges to train future scientists.

The general trend today is to consider plants and animals (including man) at the same time in studying the various processes and activities common to all forms of life. In this way the focus of attention is directed toward the generalizations and principles we set up in our objectives, rather than specific plants and animals. As Pieper, Beauchamp, and Frank point out: "We can organize our course of study around groups of plants and animals and present in detail a large number of separate species, studying their structure and life activities. Then from this body of facts and details we can attempt to formulate the important generalizations and principles of biology . . . The focus of attention in such an organization is primarily upon a description of various plants and animals. Under such a conception the principles and generalizations of biology are merely by-products of the course which may or may not be secured . . . It is true that scientists have studied with great care the various forms of life and have provided minute descriptions of these forms. This type of study was necessary to provide data from which principles could be formulated. The goal of the scientist, however, is the principle; the details concerning each form of life represent simply the raw data from which principles are derived. When we ask pupils to memorize the details concerning types of plants and animals, we are asking them to memorize the raw data. In other words, we are setting up the data as an end product rather than as a means for understanding principles."[7]

The first step in organization of materials for instruction in biology that is in agreement with the present philosophy of education, is the determination of the problems that will have direct relation to the criteria set up by Prof. Ferris. That is, problems that deal with the actual activities and interests of adolescents and the biological needs of the society in which they live. If we may define biology as the science dealing with the fundamental life *processes* and *activities* of living things, we have a real basis for our organization of a course in biology. If we should stop to analyze these two factors common to all living things, we find that they may be classified under the following understandings: (1) supplying and using food; (2) growth; (3) reproduction; (4) dependence upon and adaptation to environment; (5) relationship and inter-relationship of living things; (6) behavior; (7) man's control, improvement, and conservation of life. These problems suggest the basis for our major understandings or units in our course of study. Of course these may be restated, re-arranged, combined, or sub-divided in a variety of ways. Whether we organize them logically or psychologically, we must always fit the situation to the viewpoint of the child in his local surroundings. If we remember that these understandings and the pupil's conception of generalizations and principles grow from day to day, our psychological approach will become logical.

The reader will notice that the title of this paper is called "Unit Planning in Biology." The reason for this is obvious to every present-day teacher. Ever since Professor Morrison used the term in connection with organization of courses of study, the word "unit" has become accepted by teachers and curriculum workers. If we organize our subject-matter around a series of important understandings, as suggested above, we may define this as unit planning. These major understandings we may call units. Perhaps in the future they may be called by some other word, but at present we shall cling to the current term.

The organization of the materials for instruction into units is merely the starting point of unit planning. We must carefully analyze each unit: (1) into understandings or principles in the light of the objectives we have set up; (2) organize these understandings into problems and sub-problems which focus the attention of the pupil on these understandings; (3) then we must

Continued on Page Thirty

You Should Read

New World of Chemistry

• *By* BERNARD JAFFE, Chairman, Department of Physical Sciences, Bushwick High School, New York City; New York; Silver, Burdett and Company, 1935. xxviii + 566 pp. $1.80.

When he was examining this textbook a chemistry teacher of long and varied experience said to me, "If I had owned a book like this when I was a student in high school, it would have been priceless!" That statement gives an idea of the kind of inspiring and instructive textbook that Dr. Jaffe has written. Throughout the abundant factual matter of the book he has woven stimulating material relating to the achievements of scientists, the part played by research in the development of chemistry, the value of theories in the advance of science and their aid in unifying and coordinating the student's growing knowledge of chemistry.

The sequence of units is admirable, much better, I believe, than in most high school texts. The early introduction of formulas and valence is a good feature. The chapter dealing with electrons and protons is especially fine, the best I have found in an elementary text.

Many types of problems are considered in the chapter dealing with the mathematics of chemistry. The summary and questions at the close of each chapter are a feature common to most modern chemistry textbooks, but Dr. Jaffe grades and develops the material in an unusually satisfactory manner. The reference matter in the Appendix is well arranged. The list of Nobel Prize winners is worth while.

The book is well made. It is substantially sewed and bound, the paper is of good quality, the print is clear, the drawings easy to interpret, and the photographs modern and appropriate. The book lies almost flat when open, a very pleasing feature.

On the whole, I consider this book an excellent text. Pupils will like it; so will teachers. It deserves a place in any science library.

William H. Neely,
Fifth Avenue High School, Pittsburgh.

Laboratory and Workbook Units in Chemistry

• *By* MAURICE U. AMES, Chairman, Department of Physical Sciences, George Washington High School, New York City, and Bernard Jaffe, Chairman, Department of Physical Sciences, Bushwick High School, New York City; New York; Silver, Burdett and Company, 1935. xiv + 40 pp. $ .84, Consumable Edition. $1.08, Non-consumable Edition.

This excellent manual which is offered in both consumable and non-consumable editions contains a well selected group of chemical experiments arranged in fifty-one units. It is designed to meet the needs of a complete course in high school chemistry.

Each unit is divided into sections headed: Experiments; Observations and Questions on the Experiments; Conclusions; Supplementary Exercises and Optional Questions. The experiments of each unit can be performed in a single laboratory period. Certain exercises are recommended for demonstration. Cost and convenience as well as time have been considered in the selection of experiments. The use of expensive and complicated apparatus and of costly materials has been avoided. The apparatus required is found in practically all high school laboratories. Directions are simple, clear and concise. The questions and observations on the experiments and the conclusions to be drawn are of the completion type. Splendid optional exercises are provided for the student of more than usual ability or interest. Provision is made for review.

The manual contains as a frontispiece a complete set of drawings of all the apparatus used in the various experiments. The name of each piece is given. This is an excellent help. Other drawings are scattered throughout the book wherever they are needed. A list of the apparatus and materials necessary for each unit is given in the Appendix. Tables of atomic weights, valences, solubilities and others of a similar nature are included.

This manual is a careful and thorough piece of work. It can be recommended for use in almost any type of course in high school chemistry.

William H. Neely.

Exploring the World of Science

• *By* CHARLES H. LAKE, Superintendent of Schools, Cleveland; HENRY P. HARLEY, Fairmount Junior High Training School, Cleveland, and LOUIS E. WELTON, Assistant Principal, John Hay High School, Cleveland; New York; Silver, Burdett and Company, 1935. ix + 692 pp. $1.80.

This textbook is one of the best in its field.

To be satisfactory for use today, even by an average ninth-grade student, a general science textbook should be one which in every detail, whether of external appearance or internal arrangement and content, combines the latest and best of what science itself has to give. *Exploring the World of Science* complies with this requirement in the following respects: mechanical make-up, division into units and subsequent redivision, content, style, general presentation, problem-solving arrangement, tests, references, projects and reports. In each of these points the authors have succeeded in making the text up-to-date.

In their selection of material, which is unusually good, the authors have drawn upon their long experience as teachers of science and their first-hand knowledge of pupils of adolescent age. Explanations are thoroughly and logically given, although in a few cases they may be considered to be somewhat too extensive and detailed for the immature mind of the freshman high school student.

The work is especially well motivated. Short "exploring" stories at the beginning of each unit, and "Do you know?" questions at the opening of each chapter attract the attention and interest of the student and lead him naturally into the study of the material which follows. The photographs and drawings are well chosen and well executed. Their legends are clear and informative. This is greatly to be desired for students often learn from illustrations more readily than they do from long and detailed explanations.

As a whole, this textbook is more than merely satisfactory. It is good. With it even the inexperienced teacher should get good results.

Sister Mary Margaret, O.S.F.,
St. Michael's School, Pittsburgh.

A General Science Workbook

●*By* LAKE, WELTON and ADELL; New York; Silver, Burdett and Company, 1932. vi + 346 pp. $ .80.

The material of this workbook consists of a series of 130 exercises in general science, organized into the same sixteen units that are found in *Exploring the World of Science* by Lake, Harley and Welton. The experiments that have been selected are practical, interesting and diversified. The student is encouraged to think independently, to reason about what he observes. The directions are clear and accurate.

All units are motivated. At the beginning of each unit are exploratory and overview questions which develop interest. For special student assignments and reports, readings in books of popular science are listed. Each unit includes many questions for study, and a group of important words with the spelling and use of which the student should become familiar.

This workbook can be used to advantage with any textbook of general science.

Sister Mary Margaret, O.S.F.

The Living World

●*By* HELEN GARDNER MANK, Head of the Department of Biology, Lawrence, Massachusetts, High School; Benj. H. Sanborn & Co., 1934. xxiv + 673 pp. $1.68.

"*The Living World*" is a living text. It opens with the students' practical, yet undeveloped interest—Insects. It shows their adaptation to life, their struggle for existence, their value and menace to man. The life histories and means of extermination of insects give the student a peep into methods of research. The clear and accurate description of the manufacture of food, osmosis, digestion, and assimilation expand the mind naturally and gradually. This discussion turns logically to plant, then to seed life, which in turn leads to the development of bacteria and disease. A practical, cultural knowledge which should become a part of every intelligent student and citizen is stimulated by the units "*Ways of Living*," "*Forests and Forestry*" and the "*Balance in Nature*."

Two main purposes pervade the book throughout: the adaptation of organisms to such primary necessities as obtaining food and overcoming enemies; and the distinct effort to train the pupil to observe accurately and to discover things for himself. To secure the former, the author stresses practical feeding experiments with animals; for the latter, the laboratory directions and questions precede the text material.

The material is lively and accurately presented. It is up-to-date; the vocabulary is well suited to the student's experience; the illustrations are abundant, well selected, and instructive. The book contains a wealth of material, too much to teach satisfactorily in a year, yet it is written in such an easy style that it will inspire the student to study on for the fun of it. A glossary, helpful references, and well arranged index complete the development of "*The Living World*."

Field trips, catching of butterflies, grasshoppers, water insects, garden insects and the like are somewhat unpractical for limited periods and for city youngsters, some of whom are so far from meadows and ponds that they recognize the advent of spring only by the change in the fall seasons. However, the wide selection of experiments, and the thorough drill offered by the workbook offset this difficulty and provide more than enough material to accomplish the purpose.

Sister M. Lawrence, R.S.M.,
Mt. Mercy Academy, Pittsburgh.

Science At Work

●*By* ANNA B. REGENSTEIN and WILLIAM RAY TEETERS; New York; Rand, McNally and Company, 1935. xi + 628 pp. $1.68.

A copy of this text was given to a high school pupil of average intelligence with the request that he express his opinion of "general science." From the manner in which this student has asked questions that were provoked by his reading (not study) of the text, it is apparent that scientific curiosity is easily fostered by the matter contained in the book and the way in which it is presented. This seems to be especially true of the previews and the investigating activities section connected with each unit.

The units are well chosen. They are not too lengthy, and their order of arrangement is such that the more difficult matter is presented only after the pupil has become familiar with the necessary technical terms and their applications. The motivating problems given in the units leave freedom for personal choice. The power questions are so suggestive as to compel the student to devise more of them. The summaries, in question form, which follow the units are highly commendable because the student *must* know the content matter of the unit before he can solve them. This cannot be said of such summaries in all other modern textbooks.

Special fields within the major sciences are well treated, the subject matter being clear and complete enough to insure an understanding of it by the ordinary student. The biological section is particularly interesting. The units dealing with the sanitary condition of homes, the preservation of health, and medical care are all practical. They create an incentive for civic pride and progress in these activities, in both rural and urban districts. Chemical principles are presented in such a way as to make objects of interest out of many common articles in daily use in the home. Such things will no longer "just happen to be." Practical physics and physical theories have been so cleverly blended that the dryness of chemical terms and their definitions is forgotten. A desire for the future study of the separate sciences is created.

The vocabulary is entirely within the student's comprehension. The descriptions entice the student to read "just one more paragraph." Interest is not killed by long drawn out explanations. Applications and illustrations are modern, and their up-to-dateness is emphasized by pictures and descriptions of primitive activities, or lack of activities, in certain scientific fields. Laboratory experiments are highly suggestive. The directions for their performance are so clear and the required apparatus is so carefully pictured that fully a third of the exercises can be carried out without a great deal of supervision. They are even tempting enough to inspire their doing at home.

The book is attractive in appearance. The binding is good, the type clear and legible, and the paper of dull finish and good quality. The index, table of contents, and bibliography are quite complete. There is also a glossary and, as such, it is good. To the average student, however, this section may be a hindrance rather than an aid. Glossaries frequently encourage a tendency to memorize definitions of terms in such a mechanical manner that their meanings and applications are almost wholly lost. In the reviewer's opinion a pronouncing vocabulary with a key to pronunciation would be far more beneficial.

"Science at Work" is a highly desirable text, one of the best. It accomplishes the aims which the authors list in the preface. The material selected and the man-

Continued on Page Thirty-four

How Earthquakes Are Recorded

Continued from Page Ten

reflecting a light spot back and forth across the photographic paper to give us our record.

When an earthquake occurs, then, the whole earth quivers and this quivering can be detected by seismographs, utilizing the principle of inertia. But how can we tell from a record of this quivering just where the earth did quake?

When the earth quakes, it sends throughout the earth two distinct kinds of quivers—two distinct kinds of ripples which travel at different rates. Just as in a thunder storm at each lightning discharge we both see the lightning and hear the thunder because both a light wave and a sound wave are sent out from the disturbance in the clouds, so in an earthquake two distinct kinds of waves are sent out—one pushing the earth ahead of it and hence called a compressional wave, and the other shaking the earth from side to side as it travels and hence called a transverse wave. Like the thunder and the lightning waves, these two earthquake waves travel at different rates—about five and three miles per second respectively. For every second we can count between the thunder and lightning waves, the distance of the thunderbolt is one-fifth of a mile from the observer. So for every second we can count between the compressional and transverse waves of an earthquake, the quake is a corresponding distance away—for instance, in the Utah quake of March 12, the number of seconds counted between the two quake waves was two hundred and ninety-three, amounting to a distance of one thousand nine hundred and forty miles. The seismograph records the arrival of these waves, and the exact second at which each arrives is told by time marks placed automatically on the record by an accurate clock.

So much, then, for the distance of a quake from a given observatory, determined by the number of seconds elapsing between the arrival of the compressional and transverse earthquake waves. But how is the direction determined? If we have three stations in communication, the matter is simple. If we describe three circles on a globe with each of the three stations as centres and the distances of the quakes from the respective stations as radii, the three circles can only intersect at one point and that point is the centre of the quake. With sufficient instruments we can locate the position of the quake from the records of a single station but the description of such a method is beyond the scope of so short an article.

What practical results has seismology achieved, one naturally asks. The new seismology or the scientific study of earthquakes since its birth around 1895 has busied itself mainly with four lines of investigation: What can seismology tell us about the nature of the earth's interior; how can seismology be used in prospecting for oil, coal and such materials; how can we construct buildings that will withstand earthquake shocks, and, lastly, how can we foretell when an earthquake is due in any given locality?

Much progress has been made along all four lines. We have now a fairly accurate picture of the internal structure of the earth. Seismology has, as it were, let down its camera into the interior and photographed it for us. We find it to be a solid sphere with a dense core probably of iron or nickel starting about half-way down, like the core of a baseball.

For years the interior of the earth was thought to be liquid. Even text-books as late as 1929 so described the earth, but a liquid core does not fit in with the findings of seismology.

Attempts have been made to find out something of the nature of the earth's interior by boring wells, and wells of several miles were sunk, but such wells are but a scratch on the earth's surface. How, then,, has seismology succeeded in digging down into the earth? Facetiously, one might say it is quite a deep story.

Two different waves, as we have said, travel out from the scene of every earthquake to all points of the earth—the waves travelling at different rates, hence arriving at different times at the observing station. If an observatory is within a distance of seven thousand miles from the quake, these two waves will both be recorded, but it was noticed as the number of stations began to increase that if a station or observatory was more than seven thousand miles but less than ten thousand miles away, it failed to record these waves, even though it was equipped with the best instruments. On the other hand, a station ten thousand miles away with far inferior equipment would record at least the first wave. In other words, it became evident that there was a definite blind spot for earthquake waves. This blind spot proved to be, for each station, a belt three thousand miles wide circling the earth. Such a blind area exists for every quake beginning at a distance of seven thousand miles from the quake and ending at a distance of ten thousand miles from the quake. Any observatory situated within the belt—that is any station farther than seven thousand miles and less than ten thousand miles from the quake, will fail to record the waves we have spoken of. There are no such waves to be recorded in the area—what has happened to them?

The explanation is that the waves travelling out in all directions through the earth from the earthquake finally struck the core of the earth, much more dense than the crust, and were bent out of their path somewhat by this core. Glass does the same thing to light waves. It bends them out of their straight path. A periscope, for instance, bends the light around corners so that a person in a trench can see through the periscope what is going on outside. The phenomenon is called refraction or breaking back. It can be shown very simply in the case of light waves by means of a wash basin equipped with running water. If a person puts the waste plug in the basin and stands off away from the basin just far enough so that it is impossible to see the plug over the edge of the basin and then asks a second person to turn on the water, the

Continued on Page Twenty-four

SPECTROSCOPES

for Elementary Chemical Work

In elementary chemistry, the spectroscope must necessarily be simplified as much as possible for student use, yet it should be fully equipped to thoroughly cover any classroom needs. Bausch & Lomb, therefore, offer these two instruments — the Bunsen and the Wavelength Spectroscopes.

Bunsen Spectroscope

BUNSEN SPECTROSCOPE—Ideal teaching instrument for general college work. Prism is movable for teaching physics of the instrument. Slit scale and viewing telescope are focusable. Telescope swings right or left. This instrument is of the knock-down type to facilitate storage when not in use.

Wavelength Spectroscope

WAVELENGTH SPECTROSCOPE — Valuable for qualitative analyses. Calibrated with a wavelength scale so that students can refer to handbooks and reference literature for identifying materials by prominent lines. Prism movable and slit adjustable. Camera can be added for advanced spectrographic instruction or for making records or notebook illustrations. For complete details write for booklet No. D221 to Bausch & Lomb Optical Company, 696 St. Paul Street, Rochester, N. Y.

Bausch & Lomb

WE MAKE OUR OWN GLASS TO INSURE STANDARDIZED PRODUCTION

FOR YOUR GLASSES, INSIST ON B & L ORTHOGON LENSES AND B & L FRAMES

How Earthquakes Are Recorded

Continued from Page Twenty-two

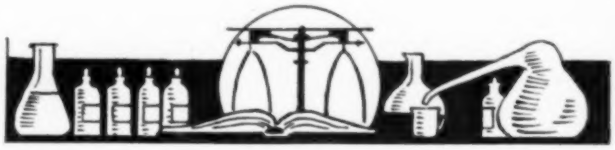
plug until now invisible will begin to be seen by the first observer as the water rises in the basin. The water bends the light coming from the plug to the observer, and enables him to see it around the edge of brim. The phenomenon is more striking if the basin is first filled and the observer backs away so that he can just see the entire circle of the waste pipe at the bottom of the basin. If a second person now removes the plug from the basin so as to let the water out, the waste outlet will disappear from view—the edge of the basin is obstructing his view and the water no longer is there to bend the light around this edge for him.

This is one example of the bending or refraction of light waves by a dense substance such as water. The core of the earth bends earthquake waves in the same way and bends them away from the blind belt that we spoke of above. From the amount that the earthquake waves are bent we can tell how much of the core there must be—just as we could tell how much water was in the basin from the amount the light was bent.

But how do we know that the core is solid? A liquid core would bend the waves just as well. Now thereby hangs a tale, as the little girl said of her missing pony.

The two earthquake waves above referred to are due respectively to what we call the elasticity of shape and volume. The wave which is due to the elasticity of volume can travel in solid or liquid because both solids and liquids have definite volumes of their own. The wave which is due to the elasticity of shape can travel in a solid only because a liquid has no shape. The water in a glass, for instance, has to take the shape of the glass. The first wave, therefore, will pass through the core of the earth whether the core is solid or liquid. The second will pass through only if the core is solid.

For many years it was thought that the second wave did not pass through the core because it had never been observed at earthquake observatories, but it has in recent years been observed so that we now know the earth's core does transmit both waves of shape and waves of volume—hence the earth's core is solid. Seismology has taught us that the earth is solid right through, but that the core of the earth starting about one-half way down is much more dense than the rest and is probably made of iron or nickel or such metals.



The Place of General Science

Continued from Page Fourteen

for teaching science. This group includes textbooks, a reference library, equipment for demonstrating the principles of science, and a laboratory. Because each of these tools enters into the development of other topics later, they are only mentioned here. However, it may be said that while certain studies have shown that some science textbooks are inaccurate and poorly organized, other textbooks have reached a high standard of accuracy and organization. Recent tendencies seem to indicate that both authors and publishers are cooperating to prepare accurate and well organized textbooks for the use of boys and girls. Teachers should study critically the books which they recommend for the use of their pupils. For the reference library there is a wealth of books and magazines. The great problem is to choose a few wisely. The same may be said of equipment for demonstrations. Gifted pupils should be encouraged to make equipment. Supplies which cannot be grown, collected, or made can be furnished by supply houses. The only limit on the supply is the judgment of the teacher and the amount of money available. Effective science teaching necessarily implies adequate facilities for work. This means a work room (laboratory) with the minimum essentials of running water, gas, and electricity. Even though excellent results in science teaching have been obtained with very poor facilities, a good laboratory is a great aid to both teachers and pupils.

Another factor in science education is the subject matter or content of the science curriculum. As has been stated before, the science curriculum comprises the grades from the kindergarten through the high school. The science curriculum also implies a purposefully integrated selection of subject matter which will meet the needs of the pupil at each grade level. Unfortunately, educational research has not answered the question, "What science subject matter shall be taught at each grade level?" In English, for instance, the subject matter to be presented at each grade level has been worked out carefully so that the child may make the greatest progress. A definite course is outlined for each grade. The same is true for mathematics from the kindergarten through the university. Although some worthwhile attempts have been made in this direction in the field of science, this is one of the problems which must be given further study.

Makers of science curricula have certain criteria by which they may judge the content of the science course. Some of these criteria are: (1) Only subject matter should be presented which has use value. If the pupil will not use it, why should he learn it? (2) Subject matter should be taken from the pupil's environment. The solution of every problem should give him the answer to questions which naturally arise from his attempt to understand his environment. In this way science teaching will aid him in his complete adjustment to his environment. (3) The subject matter should be of such a nature that it includes learning activities. Problems which involve physical as well as mental activity should be used. (4) Subject matter should be presented which will bring out principles and generalizations which the pupil of that grade level can understand. (5) Subject matter for the elementary and high schools should be chosen so that it can be organized around the major principles and generalizations of science. When the major principles and generalizations are used as the unifying theme, the sharp breaks between science subjects are eliminated and the pupil's progress from grade to grade is unbroken. The major principles and generalizations permeate all the courses of natural science. They are the unifying structure of all science courses. A science curriculum organized in this way approaches the ideal of integration.

In the kindergarten or first grade, the child can form the concept that the earth receives heat from the sun. This may be the beginning of one of the major generalizations of science, that is, "Life upon the earth is dependent upon the energy received from the sun." This concept will be still further enlarged by the knowledge that burning is the uniting of a substance with oxygen and the release of heat. As the child progresses in his science work, he will enlarge this concept by learning that the heat given off by the burning of wood, gas, petroleum, and oil came indirectly from the sun. Later his concept will be enlarged by the knowledge that heat is a form of radiant energy from the sun. When he learns that the chlorophyl of a green plant takes in and stores up energy from the sun in the tissues of the plant, his concept will be still further enlarged. A study of the chemical processes of his own body will show him that indirectly the energy which makes his life possible comes from the sun. From this illustration it is evident that facts and data are used as a means to an end. They are used to make the principles and generalizations of science meaningful to boys and girls.

Another vital factor in the problem of science education is a method of presenting subject matter. Pupils remain about the same from one generation to another. The tools of teaching have been improved. Teachers have improved, but undoubtedly much of their improvement in teaching is due to the improved tools and the improved methods of presenting subject matter which they employ. Fortunately, progress in educational research has given us many tested methods of presenting subject matter. One of the tested methods of presentation is the unit. A unit is a closely related body of subject matter representing an outstanding problem of the pupil's environment. The unit is divided into major problems and the major problems are subdivided into minor problems so that they can be mastered more easily. Problem solving is the method of science. A unit is organized around related principles and generalizations of science. The following problem was

chosen in the ninth grade for a unit on heat and subdivided as follows:

How Does Man Secure Heat for his Daily Needs?

Problem 1. From what source does man secure heat?

Subproblems:

Why do we need heat in our homes?

What are the principal fuels, and how does man use them as sources of heat?

How is a flame produced, and what are some of the products of combustion?

Are there other sources of heat besides fuels?

Problem 2. How does heat serve man?

Subproblems:

How is temperature measured, and what is the unit of heat?

How are solids and liquids affected by changes in temperature?

How is heat transferred from place to place?

How is heat transferred in cooking and in heating homes?

Some of the principles and generalizations which the pupils learned from this unit are: (1) The sun is the earth's greatest source of heat. (2) The heat of fuels is released by burning. (3) When a fuel burns it combines with oxygen. (4) Heat is one of the forms of energy. (5) The energy in gas, petroleum, and coal was taken in from the sun and stored up by green plants millions of years ago. (6) Heat is transferred from place to place by convection, conduction, and radiation.

In this unit the learning activities were organized to bring out the principles and generalizations which the pupil will need in future science work in solving the problems of his environment. The facts and demonstrations used in the learning activities led the pupil to the desired end for the unit, namely, the understanding of principles and generalizations.

It is impossible to leave the subject of presentation of subject matter without mentioning the use of the science workbook. The old method of merely assigning lessons, textbook study, and using a recitation period for hearing the lessons is now generally condemned. It is not only a waste of the pupil's time but kills his interest and initiative. The old educational adage that, "Pupils learn to do by doing," is still one of the fundamental principles of learning. Yet many teachers seem to have forgotten it. The workbook presents the opportunity to every science teacher to leave the old path and enter upon a real activity program with the pupils. The better science workbooks are organized on the unit basis. The units are major problems taken from the pupil's environment. The problems are made up of activities which aid the pupil in solving the problems of his everyday life. The problems are concrete and appeal to the pupil as worth while. The pupil finds himself engaged in purposeful activity, that is, the solving of problems to which he wants to know the answer. The problems are designed to lead the pupil through the solution with interest and satisfaction. He gets the experience of satisfaction from the successful solution of his problem. Questions and exclamations

of surprise arise spontaneously because the pupil is engaged in solving a problem which is real to him. The pupil recognizes the principles and generalizations as the foundation blocks in the great structure of science. As these great principles and generalizations emerge, the superior teacher will seize the opportunity to make them stand out in their true perspective. Because of the pupil's interest and activity, these principles and generalizations will become part of the pupil's storehouse of useful knowledge.

In this type of presentation the superior pupils should be encouraged to collect and grow specimens for demonstrations. Those with mechanical ability will be eager to make apparatus to demonstrate the principles of science. There is usually more than one way to demonstrate a principle. Teachers who can stimulate pupils to devise new or different methods for demonstrating a scientific principle have achieved the highest level of teaching. The workbook method of teaching will enable both the experienced and the inexperienced teacher to reach new high levels of instruction.

The science library should be a valuable tool in the teaching of science. The biographies of the great scientists should give the pupil a profound respect for the methods of science and the value of truth (tested knowledge). Vicariously the pupil will work through the problems of these great men of science and with them share their attitudes and arrive at their conclusions. In this day when our educators are clamoring almost hysterically for the schools to prepare a type of citizen which will save our country from economic disaster, it would seem that the science teacher has a great opportunity. The history of science in every age shows great scientists who represent the highest type of unselfish citizenship. The pupils should know the simple story of Pasteur who silenced the terrifying cry of "Mad dog," and his work in immunization which has saved millions of men, women, and children from an untimely death. The electrical experiments of Faraday which resulted in the electric generator and motor should be known to every boy and girl. The work of this man laid the foundations for the use of electricity in our industrial world today. Every pupil should know the unselfish work of Doctor Walter Reed and his associates which practically banished yellow fever from the civilized world and made it possible for the white man to go to the tropics and return alive to his family.

Perhaps it would be stretching the principle of the transfer of learning too far to imagine that from studying the lives of these and other great scientists a pupil might catch the spirit of unselfish citizenship and carry it over to the solution of some of the political and economic problems of our troubled world. What would happen if some of our science pupils of today attacked the problems of our crime ridden country in the same spirit in which these scientists attacked their

problems? The applications of science have lifted the shackles of drudgery from our people. Undoubtedly, the methods and spirit of the great scientists, if applied to our political and economic problems, would lead soon to their solution. One of the outstanding aims of the teacher in the use of the science library should be to inculcate this spirit in every pupil of science.

Probably the reader has begun to wonder when the question, "What is the place of general science in the integrated science curriculum?" will be answered. Although the science teaching of every grade is vital, the teaching of general science in the ninth grade is especially important. In spite of our school laws many children complete their school work at the ninth grade level. If the pupil ends his school career with the ninth grade, his preparation in science should have helped him as completely as possible to attack life's problems and adjust himself to his environment. If the pupil continues his education in the high school, his preparation in science should help him to adjust himself in any course which he may choose to follow and give him the foundation for successful pursuit of that course. In order to attain these objectives of general science in the ninth grade, the subject matter should be taken largely from the pupil's environment. The problems should be concrete and not abstract and technical. The subject matter should abound with illustrations taken from everyday life. General science in the ninth grade should recall the principles and generalizations of the science of the grades and junior high school and fix them in their true perspective and enlarge them as the foundation blocks of science. General science should be the keystone in the science structure of the elementary grades. At the same time, it should become the corner-stone of the science structure for the solution of problems in everyday life and for future work in science.

The Teaching of General Science

Continued from Page Sixteen

stration exercises should be distributed throughout the text or segregated at the end of the units. If placed at the end of the unit, they do not break the continuity of the student's reading, which is an advantage.

Another essential which should be looked for in a general science text is the glossary. This is a very important aid. Students at the eighth or ninth grade level know how to use a dictionary. However, when studying science for the first time, pupils are quite likely to become confused when, upon consulting the dictionary, they find several definitions for the same word. If a glossary is present in the book they have at hand, they will be able to get the right meaning of the term as it is used in the text.

In many schools dictionaries are not always available to the student at the time they are needed. All textbooks should contain sufficient aids of the kinds mentioned. In the writer's opinion, the more comprehensive the book is, the better.

The make-up of the book should not be overlooked. While the cover, paper, type, drawings, and illustrations do not make a book, they go a long way in making a complete unit. The cover should be well designed and made of some washable and durable material. The paper should not be of the glossy type which tires the eyes. The type should be sufficiently black and properly spaced so that the page will not appear overcrowded. Various sizes of type are desirable for setting off the divisions of the subject matter and the text in general.

In this discussion, points of a practical nature have been emphasied. Some of the problems encountered in the actual teaching of general science have been mentioned. This does not mean that the theoretical problems and problems of method should be overlooked. Such problems should always be kept in mind and improvements made whenever possible. Oftentimes, however, processes worked out under ideal conditions in the laboratory do not function properly when applied in the factory.

Translating Science Into News

Continued from Page Three

factory owners and aldermen—witness his dramatic show with the anthrax-afflicted sheep. In our own day, men like Sir James Jeans and the late Sir J. Arthur Thompson have written science books that have sold like novels. But most scientists remain ingloriously mute.

The success of such books as those just cited, and the increasing amount of space which newspapers and magazines are devoting to articles on scientific subjects, are strong evidence that the people are ready to have the gospel of science preached to them. The possible harvest is great, but the laborers are as yet far too few.

The rather notable success that has been achieved in a few years by science writers for the press has to some extent concealed the great gaps that are still unfilled. Furthermore, even yet far too few persons really trained in science are actively engaged in the work. Most of the present popular science writers emulate Francis Bacon, both in brashly taking all knowledge to be their province—and in being very sketchily trained in any particular science. A great newspaper, which would never think of asking a football specialist to report a horse-race, will still cheerfully send its "science editor," a man who perhaps had one elementary course in chemistry, to cover a meeting of astronomers or psychologists!

Scientists themselves, men and women actually engaged in teaching and research, can do much to improve the situation. It takes only a knowledge of their own subject (which they may be presumed to have), and the ability to state a fact briefly and clearly in plain English—which a teacher should also have, if he is to possess his job in honesty. The one added thing needed is a little study of the method of presentation required for popular reading. It is different from elementary classroom presentation, but no more difficult.

While all the tricks of the trade cannot be imparted in the scope of one short article, at least a few hints are possible, which any alert science teacher can enlarge and improve upon. And most editors of newspapers, especially in middle-sized and small places, will be glad enough to have an occasional well-built "science yarn" by a local person, with a local news angle to it. It won't take much "selling"—especially if you are willing to turn out an occasional bit without pay, just for the glory of old St. Siwash—and the good of your own department.

First, then, look at your audience: the readers of the paper, instead of the students in your lecture room. Ask yourself, can they be interested in what I have to tell them? Don't underestimate either their potential interest or their basic intelligence; it is likely to be rather high, on both counts. The trick is to capture their initial interest, to get their attention.

That is the job of what newspapermen call the "lead." A good newspaper story does not necessarily start with its most important fact, or with its first fact, to be followed in logical order by all the rest of the facts—like a zoology textbook proceeding from ameba to mammal. A good newspaper story starts with the most *interesting* fact, even if it seems a relatively trivial one. The "lead" is the red skin on the apple: it is what makes the reader bite. Once he has taken the initial bite, you can go ahead and feed him the rest of your story in whatever order you think is at once appetizing and instructive. And you can (and should) work into it a statement of the fundamental principle involved. Not tagged on, like a moral ending to a Sunday-school story of the last century, but worked into the fabric of the statement itself.

Be brief. Modern newspapers have terrific demands on their space, and a story of three hundred words, that tells one fact and one inference therefrom interestingly, stands more than twice the chance of being used than one of double that length that tries to tell three or five facts. Come back later with the rest of the stuff, in separate packages, and you will find the market much better.

Don't be too technical. Most readers shy off from "big words"—except those they are already familiar with. They are not afraid of chrysanthemums and narcissi, but they are apt to balk at swallowing aspergillus and gramineae. We need not snigger at them for this; we all do it ourselves, somewhere or other. Also, most newspaper readers now know (or think they know) about cells and glands, atoms and electrons; though they may need a bit of explaining about genes or alpha particles. Just where you must translate, and where it is safe to assume background, is admittedly a bit difficult, and will require some experimenting, to fit local conditions. The editor's own education (and prejudices) will have a good deal of influence—sometimes too much, perhaps—at this point.

Gage the length and seriousness of your story by your judgment of its importance. The first robin is a nice little "local yarn," worth a paragraph in your home town paper. Discovery of the first telescope ever used in your school, stuck away in the basement these past eighty years, is worth sending on to the papers in the state capital—they might be glad to have it. But if your chemistry professor finds a paying use for lignin, or a party of biological students comes upon a wild hickory tree with nuts double the normal size for its species, that is a science news item of national interest, worth an immediate airmail notice, or perhaps a telegram (night press rate, collect!) to a grateful *Science Service*.

Duquesne University Conference

The fourth annual Duquesne University Conference for teachers of science in the Catholic high schools of the tri-state district will be held at the University on Saturday, February 29, 1936. An interesting program is being prepared. Any one who is interested in the teaching of high school science will be welcome. Cards of admission will not be required.

Unit Planning In Biology

Continued from Page Nineteen

consider assimilative or source materials which are to be used to develop the major understandings. This brings us back to the second step in unit planning, i.e., the resources of the local community in contributing data for attaining the important understandings. Instead of teaching the external and internal structure, the habitat, life processes, economic importance, etc., of various representative plants and animals, such as the amoeba, hydra, grasshopper, frog, or algae, mosses, ferns, etc., separately, we should consider material drawn from all levels of the plant and animal kingdom in developing the big understandings. Then the pupil will leave the course in biology with a picture of the unity of life, rather than an impression of the difference between various species of plants and animals. Every experienced biology teacher realizes that the study of these lower forms of life leads directly and naturally to a study of that most versatile of all animals, man. And in the writer's judgment, it is thus serving as an approach to human problems that biology finds its highest usefulness. (4) We must set up the pupil activities, using these assimilative materials. These activities—experiments, projects, use of textbooks, visual materials, field trips, references reading, notebooks, etc.,—should relate to the big idea of the unit, and they must require the pupil to do some independent thinking in developing his understanding of the unit idea. Unless the pupil takes an active part in the learning process, the desired change in his reaction to his environment cannot be brought about. And (5) for efficient teaching a textbook should be selected that is organized to fit the objectives and understandings mentioned above. Supplementary references may be selected that will expand and enrich the basic text and course of study. As a result, we may agree with Cole, in that—"beginning teachers are likely to find their work easier, and their teaching more satisfactory, if at first they depend rather clearly upon one or two good textbooks and, as they become more experienced in their work, deviate from these by supplementing them more and more with worth-while reference materials."

From the principles suggested by Professor Morrison, we may check to see how successfully the unit idea has been carried by applying the following questions:

1. Does the title of every unit suggest that the content intends to develop either an important understanding of general application to all forms of life, or to some important aspect of man's relation to his biological environment?
2. Does each major division of the unit bring out an idea which is clearly related to the development of the idea of the unit instead of merely introducing descriptions of particular plants and animals?
3. If the unit is divided into problems, are these problems to be answered by a general statement developed by the pupil from the data of the problem rather than by a repetition of the material making up the problem?
4. When learned, will the unit result in a new understanding of such a nature that it will permanently modify the pupil's attitude and affect his behavior?

Providing for Individual Differences

If we have organized our biology unit or units upon the basis stated above, we certainly have provided sufficient minimum essentials for the biology class as a whole. Dr. Cole sums this up as follows:

> "A core of minimum essentials in biology should be selected for the biology class as a whole. Beyond this, flexibility and freedom should be the practice, and the educational materials with which the individual pupil works should be those basic to the satisfaction of his interests and needs. Whether these interests and needs are common to the biology class as a whole should give little concern to the biology teacher. Satisfied that a satisfactory core of minimum essential subject-matter has been mastered, as demonstrated by observation, reports, drill, and examination, the biology teacher is next interested in meeting the individual needs and interest of each pupil of his class. The core of minimum essentials should be aimed toward: (1) meeting the common biological-knowledge needs of the class as a whole; (2) meeting the predominant biological needs of the out-of-school population through the media of pupils who make contact with these out-of-town groups; (3) satisfying the exploratory functions of the course; and (4) providing sufficient preparation and science background for future science courses which the pupils are likely to pursue in school."

Every pupil should be encouraged to plan and execute individual work relative to his biological interests. This may take the form of experiments, surveys of local interest, projects, reading of additional references, such as books, magazines, bulletins, etc. The pupils should incorporate in their discussions any of this additional material they have obtained from their reading, experimentation, or observation.

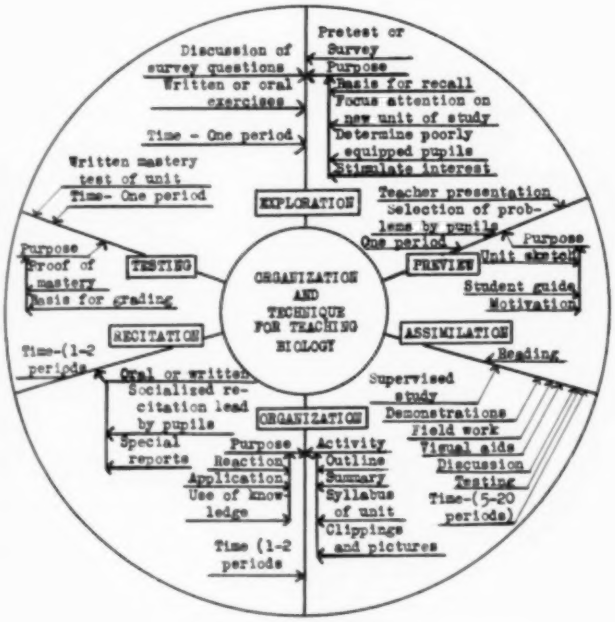
Methods of Teaching

Many of us as teachers have found from experience, observation, and from courses in methods, special techniques in which we believe and special devices which we have tried with success. Teaching and learning to teach is a continuous process. No one teacher can be pointed to, as an example of a "finished" teacher. When we begin to feel that our methods of instruction are the only methods, we have begun to stagnate. All of us can profit from the experiences of others. Some of us have experimented with different methods and have endeavored to make crude measurements of the results by use of these methods. In science conferences we hear the relative merits of teacher-demonstration versus individual-pupil-experiment, but we are still groping our way to a conclusion in this matter. Today we debate the use of different plans of techniques, whether it be the "Dalton" plan or the "Morrison" plan. But in the background of our minds, we should remember that in modern education the emphasis is placed on learning rather than on teaching. As Dewey has so well demonstrated, children learn by doing.

We should study thoroughly the different methods suggested by experienced teachers, but we need not accept any one method as final. There are valuable suggestions in all these plans. Why not modify or adapt these suggestions into a plan of your own? Use your plan, modifying it from time to time as experiment warrants. Why, for example, try only teacher-demonstrations all the time? Permit the pupils to present their experiments to the class group. They need the experience more than the teacher. Develop group leaders, permitting them to plan and to take charge of the class discussion. Informal round table discussions are of real value in arousing interest, as well as stimulating to the class. The purpose of the teacher is to plan the course of study, guide the pupils in their learning activities, and test the results of her teach-

ing, but to stay in the background. The pupil is the center of interest.

The following general plan, in the form of a graph for mere convenience, adapted from several different sources, has been found effective. In following such a plan as this, we should permit it to be elastic and flexible as the need arises.



GRAPH OF GENERAL PLAN FOR TEACHING BIOLOGY UNITS

Testing the Results

In unit planning, it is as important to measure the results of our teaching as it is to set up objectives or organize the subject-matter, as the object of teaching is the complete understanding of the principles involved. All of us realize the inadequacy of tests as a true measuring stick of our teaching, but this does not mean that we should abandon testing. There are several methods of testing results that we may use, namely: (1) exercises set by the teacher in the assimilative period; (2) self-testing exercises, to be found in the basic text or reference books, or tests made by the teacher, given from time to time to check the progress of the individual pupil during the course of the unit; (3) presentation of minimum essentials, as well as additional exercises, projects, and experiments; (4) written organization of the unit, without references, in the form of a statement or topic outline, a list of the important generalizations or principles, or a diagram of the unit; (5) formal or informal socialized recitations, on the order of the open forum, so popular today; (6) debates, formal or informal, may be used successfully, sometimes dividing the class into two groups to discuss some phase of the unit; and (7) a mastery or achievement test at the close of the unit, which will aid the teacher in giving a "grade" such as is demanded by the school authorities. The teacher should make a study of the newer types of tests, such as the standardized tests, which include the true-false, matching, multiple-choice, classification and rearrangement, completion, labeling or identification, etc. The teacher may use either her own tests or those published by other workers in biology. Construct them so that they may be easily scored. From semester to semester the teacher should carefully check her tests to see if they bring out the principles and generalizations, as well as, the factual material she wishes to test.

Conclusion

As stated at the beginning of this paper, it was not intended that the writer should answer all of the questions pertaining to unit planning, or offer a panacea for all teaching difficulties, nor that the suggestions offered should in any way interfere with the individuality of the teacher. But it should, in a small way, serve the following purposes: (1) furnish suggestions for aiding the busy teacher, especially the one who may be at sea in her teaching; (2) offer a basis for criticism by the reader, who has found in her experience with curriculum making and actual class-room situations a more scientific, as well as, teachable plan; and (3) serving, even in a minor way, to assist in modifying and enriching the lives of pupils that they may better adjust themselves to their environment and control it. The writer will be most grateful for any suggestions which the reader may wish to offer.

In the March number the writer will offer a unit, as a type, to illustrate the objectives, organization of subject-matter, into minimum and supplementary exercises, and achievement tests. This unit, for the sake of convenience is organized into a plan for the teacher, as well as, for the individual pupil. For the latter, the writer places a mimeographed copy of the student guide sheets in their hands, using it as a basis for exploration, assimilation, organization, discussion, and testing. Please remember that this is a unit plan that has its many faults, and that it is constantly undergoing changes, it is hoped for improvement, from semester to semester. It is a plan, but any plan is better than no plan at all. But the best plan will fall short, if the teacher is left out. Its success depends upon the personality, understanding, and human interest of the teacher.

BIBLIOGRAPHY

1. "Reorganization of Science in Secondary Schools," United States Bureau of Education, Bulletin, (1920), No. 26.
2. Heald, F. E., "Biology in Rural High Schools," Science Education, Vol. 14 (November, 1929), pp 345-364.
3. Powers, Eliot R. (Chairman), "A Program for Teaching Science," Thirty-first Yearbook of the National Society for the Study of Education, Part I. Public School Publishing Company, Bloomington, Ill.
4. "High School Course of Study in Biology," (For Experimentation), Department of Science and Department of Curriculum Study and Research, The Board of Public Education, Pittsburgh, Pa.
5. Ferris, Emery N., "Secondary Education in Country and Village," D. Appleton & Co., N. Y. (1927) pp. 121-122.
6. Cole, William E., "The Teaching of Biology," D. Appleton-Century Co., Inc., 35 West 32nd St., N. Y. (1934) pp. 55-56; 59.
7. Pieper, Charles J., Beauchamp, Wilbur L., and Frank, Orlin D., "Teacher's Guidebook for Everyday Problems in Biology," Scott, Foresman & Co., Chicago, Ill. (1934) pp. 2-50.
8. Morrison, H. D., "The Practice of Teaching in Secondary Schools," University of Chicago Press.

HELPFUL BOOKS AND ARTICLES ON THE TEACHING OF SCIENCE IN SECONDARY SCHOOLS

Bayles, E. E., "Fundamentals in High-School Science Teaching." Central Missouri State Teachers College Bulletin, Warrensburg, Mo. (December, 1927).

Benedict, Ralph C., "Some Contributions of Technical Research to Elementary Biology." School Science and Mathematics, XXXI (February, 1931), pp. 146-152.

Bobbit, Franklin, "How to Make a Curriculum," Houghton Mifflin Co., 2 Park St., Boston, Mass.

Brownell, H., and Wade, F. B., "The Teaching of Science and the Science Teacher." The Century Co., New York (1925).

Caldwell, Otis W., and Weller, Florence. "Biology as Judged by Thirty College Biologists," School Science and Mathematics, XXXII (1932), pp. 411-424.

Carleton, Blondell. "A Selected and Annotated Bibliography on Secondary Biology," School Science and Mathematics, XXXIII (March, 1933), pp. 308-318.

Curtis, Francis D. "Digest of Investigations in the Teaching of Science," Vol. I. (1926), and Vol. II. (1931), P. Blakiston's Sons, Philadelphia, Pa.

Downing, E. R. "Teaching Science in the Schools," Chicago University Press (1925).

Downing, E. R. "Teaching Units in Biology—An Investigation," North Central Association Quarterly, Vol. 5 (1931), pp. 453-470.

Finley, Charles W. "Biology in Secondary Schools and the Training of Biology Teachers," Contributions of Education, No. 199, Bureau of Publications, Teachers College, Columbia University 1926).

Finley, Charles W., and Caldwell, O. W. "Biology in the Public Press," Lincoln School of Teachers College, Columbia University (1923).

Frank, J. O. "How to Teach General Science," P. Blakiston's Sons, Philadelphia, Pa. (1926).

Goodykoontz, Bess. "Units of Work and the Individual," Educational Method, Vol. 12 (1932), pp. 74-78.

Halladay, P. W. "Classroom Tests in Biology," School Science and Mathematics, XXXIV. (February, 1934), pp. 187-192.

Harap, Henry. "What Should Science Teaching Accomplish" School Science and Mathematics, XXVII. (January, 1927), pp. 60-69.

Holleman, H. B. "Course of Study in Biology for Senior High School and Junior College," Science Education, XIV. (March, 1930), pp. 528-539.

Hunter, George W., and Kitch, Loran W. "Mastery Tests in Biology." American Book Company, N. Y. (1935).

Hunter, George W. "Science Teaching at Junior and Senior High School Levels," American Book Company, N. Y. (1934).

"Instruction in Science," Monograph No. 22 of the National Survey of Secondary Education. Superintendent of Documents, Washington, D. C. Bulletin No. 17 (1932).

Isenbarger, J. "Technique in Biology Teaching." School Science and Mathematics, XXV. (June, 1925), pp. 618-623.

Kinsey, Alfred C. "The Content of the Biology Course," School Science and Mathematics, XXX. (1930), pp. 374-384.

McDowell, Hazel A. "Methods of Teaching Biology," School Science and Mathematics, XXXII. (March, 1932), pp. 261-268.

Mandl, M. M. "The Project Method in High-School Biology," School Science and Mathematics, XXXI. (December, 1931), pp. 1079-1092.

Mayhall, Mildred P., and McSpadden, W. W. "Life of the Past—A Unit for a Course of Study in High-School Biology," School Science and Mathematics, XXXII. (October, 1932), pp 711-721.

Meister, Morris. "The Educational Value of Certain After-School Material and Activities in Science." Teachers College, Columbia University.

Miller, Paul L. "Articulation of Natural Science in the High School," School Science and Mathematics, XXX (1930), pp. 783-787.

Nixon, Alfred F. "Project Work in Biology," Science Education, XVII. (February, 1933), p. 42.

Norris, Valeda G., and Hunter, George W. "Methodology in Biology," School Science and Mathematics XXVIII. (1928), pp. 987-999

Perry, Winifred. "Biology Teaching and Visual Aids," School Science and Mathematics, XXXII. (May, 1932), p. 465.

Persing, Ellis C. "Present Objectives in Biology," Science Education, XVII. (February, 1933), pp. 24-34.

Ruch, G. M. "The Objective or New-Type Examination," Scott, Foresman & Company, Chicago, Ill.

Stathers, Allan. "The Micro-Projector Compared with the Individual Microscope in Teaching High-School Biology," Science Education, XVII. (February, 1933), p. 59.

Varrelman, F. A. "On Teaching Living Biology," School Science and Mathematics, XXXI (March, 1931), pp. 273-284.

Vinal, William G. "Humanizing Biology," School Science and Mathematics, XXXI. (February, 1931), pp. 228-231.

Waldron, R. A. "Teaching Biology," Science Education, XVI. (December, 1932), pp. 472-474.

Wessel, John P. "Laboratory Studies in Animal Ecology," School Science and Mathematics, XXXII. (April, 1932), pp. 371-381.

Wisconsin State Science Committee, "A Wisconsin Philosophy of Science Teaching," School Science and Mathematics, XXXII. (1932), pp. 760-764.

Woodring, M N. and others. "Enriched Teaching of Science in the High School." A Source-book for Teachers of General Science, Biology, Physics, Chemistry, and other Sciences. Teachers College, Columbia University (1928).

The Sound Film

Continued from Page Thirteen

CONCLUSIONS

Factual Questions

1. For the non-chemistry groups the results in factual learning seem to indicate that sound film can teach quickly and effectively.

2. For this particular topic and film it would seem that the non-chemistry groups acquired more from the film than the chemistry groups.

3. For the chemistry groups the results in factual learning seem best when presented by the lecture-film-recitation-film method. Comparison of all chemistry film groups with all chemistry non-film groups seems to indicate that for this topic the results in factual learning are slightly better when taught with the aid of sound film. Of course sound film can teach much larger groups and much less expensively.

4. The sound film undoubtedly enriches teaching by showing certain experiments, apparatus, commercial plants, commercial processes and scientific materials that could not be presented to or viewed by the average class in chemistry by any other means. Also it is to be expected that chemistry classes will be certain by means of good sound films to see and hear expert lecturers and technicians in action. Of course the sound film cannot teach manual skills or attain the many objectives that are possible only through close association and contact with teacher, apparatus, and chemicals.

Interest Questions

1. The film seemed to awaken more interest in the non-chemistry groups than in the chemistry groups.

2. The chemistry film groups seemed to retain more interest in questions related to the film than the chemistry non-film groups. It would seem that the film showings helped retain interest in related topics.

3. Interest in topics not related to the film did not seem to be enhanced by the film showings.

BIBLIOGRAPHY

Arnspiger, V. C. *Measuring the Effectiveness of Sound Pictures as Teaching Aids*. New York: Bureau of Publications, Teacher's College, Columbia University, 1933.

Boucher, Chauncey S. "Talking Pictures in the University of Chicago's New Educational Plan", *Education*, February, 1933.

Devereux, F. L., and others. *The Educational Talking Picture*. Chicago: University of Chicago Press, 1933.

Koon, Cline M. *Motion Pictures in Education in the United States*. Chicago: University of Chicago Press, 1934.

Rulon, P. J. *Sound Motion Pictures in Science Teaching*. Cambridge, Mass.: Harvard University Press, 1933.

Watkins, R. K. "Learning Value of Some Motion Pictures in High School Physics and General Science", *Educational Screen*, May, 1931.

Wood, Ben D., and Freeman, Frank N. *Motion Pictures in the Classroom*. Boston: Houghton Mifflin Co., 1929.

Wyman, Carl E. "Visual Aids—Of What Worth?" *Science Education*, April, 1932.

Booklets

Instructional Talking Pictures. Erpi Picture Consultants, Inc., 250 West 57th St., New York, N. Y. List of science films made by University of Chicago.

Schlesinger, H. I., and Lemon, H. B. *Oxidation and Reduction*. Chicago: University of Chicago Press, 1933.
Study guide for use with the educational sound picture of that name.

You Should Read

Continued from Page Twenty-one

ner of its presentation provoke the thought that the authors have had much experience in teaching the sciences to high school girls and boys.

Sister M. Cornelia, O.S.B.,
Immaculate Conception High School,
Connellsville, Pa.

The First Year of Chemistry

●*By* JOHN C. HESSLER, PH.D., Professor of Chemistry at Knox College; Chicago; Benjamin H. Sanborn & Co., 1934. xii + 560. $1.68.

Workbook Manual of the First Year of Chemistry

●*By* JOHN C. HESSLER; Chicago; Benjamin H. Sanborn & Co., 1934. vi + 330.

Most secondary science books, written from the modern view-point, show a decided shift in content and method. The new approach is strongly psychological; the old logical. Chemistry texts, for the most part, remain static. Authors in this science have done least to emphasize practical applications to the betterment of human life. Among recent publications *The First Year of Chemistry* has certain features which mark an improvement in secondary science texts, although there is nothing revolutionary in its exposition. Of special learning value are the descriptive illustrations, for they are designed to clarify and correlate facts in the text. The pronunciation of scientific terms as they occur is good motivation for vocabulary difficulties. Fortunately the self-testing exercises on each chapter measure the pupil's interpretative and generalizing power.

In his selection of factual material, Dr. Hessler follows the traditional school. Items in the table of contents of this recent book are almost identical with those published thirty to fifty years ago; yet the author includes all the recent theories and new processes and up-to-date findings on the elements and the structure of matter. To write understandingly of such subjects, a man must possess knowledge and experience. Dr. Hessler, a recognized scientist, has both. Still one regrets that he makes no direct attempt at unitary organization of material that emphasizes chemistry's relation to man. Units, centered about elements necessary for life, the relation of chemistry to human health and society, chemistry's contribution to the home, or industrial chemistry, if developed, would provide a background for further study of chemistry. Such stuff needs emphasis.

As this title suggests, the work is not intended as an exhaustive treatise of chemistry. Neither does the author romanticize chemical theory. Rather Dr. Hessler gives a clear, concise exposition of basic scientific principles, arranged in compact form. The style is simple. Although the type selected and its spacing is a little confusing, the physical make-up of the book is good. Dr. Hessler's book comes at a time when there is need of change in the organization of chemistry. It deserves consideration.

The companion workbook manual marks Dr. Hessler's chief departure from the conventional course. It is excellent. It avoids the extremes of over mechanization; and, at the same time, the plan provides sufficient graphic material, practical laboratory directions, and time-saving devices to make the workbook of value to both teacher and pupil.

M. G. I.

Laboratory Work for the Blind

Continued from Page Four

by feeling the contents of the appropriate zygotic box in the square. Interestingly enough these models seem helpful in aiding the normal student to visualize the Mendelian processes.

The amount of biological information and its interpretation and correlation with other fields of knowledge gained and made by the blind students during two semesters of study involving lectures, discussions, readings and the laboratory work with the wire "drawings" and with actual specimens, seems to be fully as great as that acquired by superior college students who are without the visual handicap.

Future Numbers

of The Science Counselor

In the forthcoming issues of THE SCIENCE COUNSELOR there will be many interesting articles. We are privileged to announce a few of those which will appear in early numbers.

The Museum in Science Teaching

By Dr. Andrey Avinoff, Director, Carnegie Museum, Pittsburgh.

•

The Glacier Priest

By Rev. Edward Shipsey, S.J., Head, Department of English, University of Santa Clara.

•

Science at the High School Level

By Rev. John F. Hammond, O.S.A., Villanova College.

•

Science in the Vegetable Garden

By Dr. George J. Raleigh, Cornell University.

•

How Industrial Gases are Analyzed

By H. G. Burrell, Vice-President, Burrell Technical Supply Company.

The Selection of Chemicals for Schools

By E. S. Russell, Cambosco Scientific Company, Waverley, Mass.

•

The Cultural Value of Science

By Sister Mary Claver, O.S.F., Mount Alvernia High School, Millvale, Pa.

•

The Aquarium as a Student Project

By William A. Helfrich, Titusville High School, Titusville, Pa.

•

First Aid in the Laboratory

By Professor I. J. Wernert, Niagara University.

•

Directed Study

By Mary W. Muldoon, Principal, Junior High School, Waverly, N. Y.

•

The Science Library in the High School

By Miss M. Gertrude Blanchard, Librarian, Duquesne University.

Index to Volume I 1935

Articles are listed under authors' names. Both issue and page are given. Book reviews are listed under the name of the author of the book. (R) indicates a book review. The name of the reviewer follows in parenthesis.

Printed by Duquesne University Press

., 6
., 9
., 6
., 21
e, 6
., 24
., 28
e, 17
., 25
., 22
e, 3
., 1
., 7
h, 4
., 21
h, 13
e, 12
h, 20
h, 9
h, 16
Na-
e, 8
h, 9
c., 15
c., 3
t., 5
h, 16
c., 14
ne, 14
Press